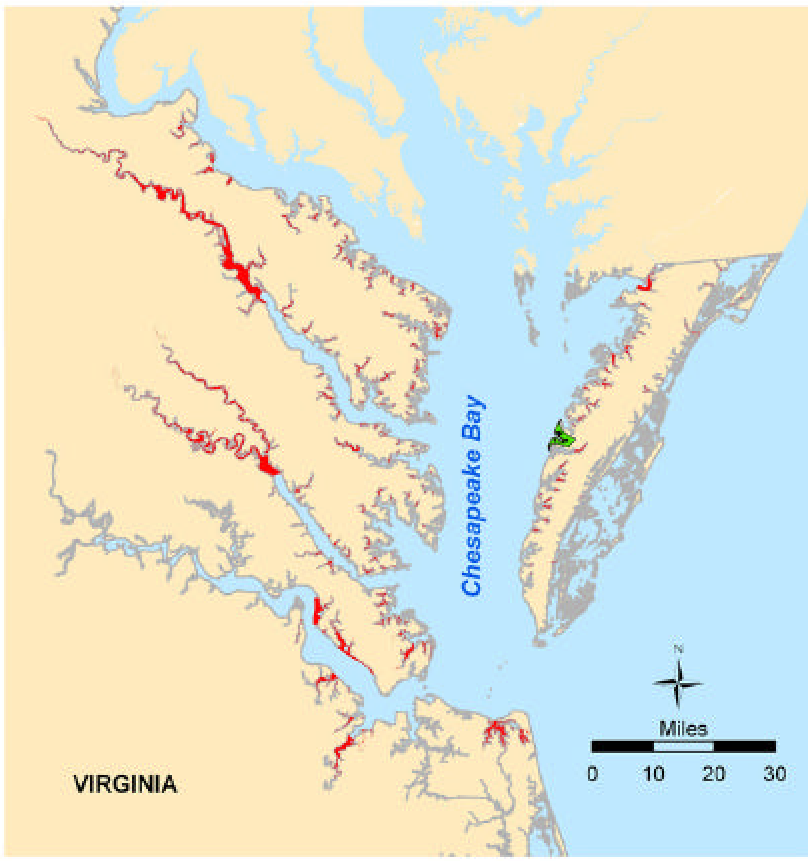
Total Maximum Daily Load (TMDL) Report for Shellfish Areas Listed Due to Bacterial Contamination

Craddock Creek



DEQ
VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

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Chesapeake Bay:
Craddock Creek
Total Maximum Daily Load (TMDL)
Report for Shellfish Condemnation Areas
Listed Due to Bacteria Contamination

DRAFT

Virginia Department of Environmental Quality

August 2005

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Total Maximum Daily Load Executive Summary

Total Maximum Daily Load Process

Management of water quality is a process intended to protect waters for a variety of uses. The first step in the process is the identification of desired uses for each waterbody. There are typically a number of physical, chemical and/or biological conditions that must exist in a waterbody to allow for a desired use to exist. In Virginia, most inshore tidal waters are identified as potential shellfish growing waters. In order to support shellfish propagation without risk to human consumers, shellfish waters must have very low levels of pathogenic organisms. Virginia, as most other states, uses fecal coliforms (FC) as an indicator of the potential presence of pathogenic organisms. To maintain the use of a waterbody for direct shellfish harvesting, the goal is to ensure the concentration of fecal coliforms entering the waterbody does not exceed a “safe” level. The safe level is set as the standard against which water quality monitoring samples are checked.

When water quality monitoring detects levels of fecal coliforms above allowable, “safe” levels, managers must identify the potential sources and plan to control them. The prescribed method for figuring out what must be controlled to attain the water quality standard is the calculation of a total maximum daily load (TMDL). The TMDL is the amount of fecal coliforms that may be introduced by each potential source without exceeding the water quality standard for fecal coliforms in shellfish growing waters.

The process of developing a shellfish water TMDL may be generalized in the following manner:

1. Water quality monitoring data are used to determine if the bacterial standard for shellfish have been violated;
2. Potential sources of fecal bacteria loading within the contributing watershed are identified;
3. The necessary reductions in fecal bacteria pollutant load to achieve the water quality standard are determined;
4. The TMDL study is presented to the public to garner comment;
5. An implementation strategy to reduce fecal bacteria loads is written into a plan for the watershed and subsequently implemented;
6. Water quality monitoring data are used to determine if the bacterial standard is being met for shellfish waters.

Different approaches can be used to determine the sources of fecal pollution in a waterbody. Two distinctly different approaches are watershed modeling and bacterial source tracking (BST). Watershed modeling begins on the land, identifying potential sources based on information about conditions in the watershed (e.g. numbers of residents, estimated wildlife populations, estimated numbers of livestock, etc.). BST begins in the water, identifying sources of fecal coliforms, specifically the dominant fecal coliform bacteria, *Escherichia coli*, found in shellfish waters based on either genetic or phenotypic characteristics of the coliforms. Virginia’s Department of Environmental Quality has decided to utilize BST, and specifically to use a method called antibiotic resistance analysis (ARA). This method identifies fecal bacteria found from four sources: humans, wildlife, livestock, and domestic will all differ in their reactions to antibiotics. Thus, when samples of fecal bacteria collected in the water quality monitoring program are exposed to specific antibiotics the pattern of responses allows matching similarities to the response patterns of bacteria from known sources which have been accumulated in a "source library". Through this analysis investigators also estimate the relative proportion of the fecal bacteria derived from each of the four general source classes and assumes this proportion reflects the relative contribution from the watershed.

The resulting estimates of the amount of fecal coliform pollution coming from each type of source can then be used to allocate reductions necessary to meet the water quality standard for shellfish growing waters. Identifying and agreeing on the means to achieve these reductions represent the TMDL implementation plan.

Continued water quality monitoring will tell whether the efforts to control sources of fecal coliforms in the watershed have succeeded.

Fecal Coliform Impairment

This document details the development of bacterial TMDLs for one segment in the Chesapeake Bay: Craddock Creek watershed in Accomack County, Virginia. The condemned area in the watershed is condemnation 195 consisting of the upper portion of Craddock Creek in Growing Area 83. The applicable state standard specifies that the number of fecal coliform bacteria shall not exceed a maximum allowable level of geometric mean of 14 most probable number (3-tube MPN method) per 100 milliliters (ml) and a 90th percentile geometric mean value of 49 MPN/100ml. (Virginia Water Quality Standard 9-VAC 25-260-5). In development of this TMDL, the 90th percentile 49 MPN/100 ml was used, since it represented the more stringent water quality standard.

Sources of Fecal Coliform

Potential sources of fecal coliform consist primarily of non-point source contributions, as there are no permitted point source discharges in the watershed. Non-point sources include wildlife; livestock; land application of bio-solids; recreational vessel discharges; failed, malfunctioning, or non-operational septic systems, and uncontrolled discharges (straight pipes conveying gray water from kitchen and laundry areas of private homes, etc.).

Water Quality Modeling

A steady state tidal prism model was used for this TMDL study because the character of the waterbodies to be modeled is relatively simple from a hydrologic perspective: for example, small in area and volume with a single, unrestricted connection to receiving waters. This approach uses the volume of the waterbody and adjusts for tidal flushing, freshwater inflow and bacterial decay in order to establish the existing and allocation conditions.

Determination of Existing Loadings

To assist in partitioning the loads from the diverse sources within the watershed, water quality samples of fecal coliform bacteria were collected for one year and evaluated using an antibiotic resistance analysis method in a process called bacterial source tracking. These samples were compared to a reference library of fecal samples from known bacteria sources. The resulting data were used to assign portions of the load within the watershed to wildlife, humans, pets or livestock. The results of this scientific analysis indicated that the primary source of fecal coliform bacteria is wildlife with livestock as secondary contributors. The presence of a large signature attributable to one source component is sufficient linkage to establish potential directions for remediation under a future implementation plan.

Load Allocation Scenarios

The next step in the TMDL process was to determine the appropriate water quality standard to be applied. This was set as the 90th percentile standard because the data established that the 90th percentile required the greater reduction. Calculated results of the model for each segment were used to establish the existing load in the stream system. The load necessary to meet water quality standards was calculated in a similar fashion using the water quality standard criterion in place of the ambient water quality value. The difference between these two numbers, the existing bacteria load and the water quality standards load, represents the necessary level of bacteria reduction in each impaired stream segment.

Finally the results of the BST analysis developed for each segment were used to partition the load allocation that would meet water quality standards according to source. The results of the model, the BST source partitioning and the reductions necessary for each segment are shown in the table below.

Reduction based upon 90TH PERCENTILE Standard
Growing Area 83: Chesapeake Bay Craddock Creek Watershed

Condemnation Area	Source	BST Allocation % of Total Load	Current Load (MPN/ day)	Load Allocation (MPN/ day)	Reduction Needed
195 Craddock Creek	Livestock	15	2.97E+10	0.00E+00	100.0%
	Wildlife	32	6.34E+10	2.36E+10	62.8%
	Human	26	5.15E+10	0.00E+00	100.0%
	Pets	27	5.35E+10	0.00E+00	100.0%
	Total	100	**1.98E+11**	**2.36E+10**	**88.1**

Margin of Safety

In order to account for uncertainty in modeled output, a margin of safety (MOS) was incorporated into the TMDL development process by making very conservative choices. A margin of safety can be incorporated implicitly in the model through the use of conservative estimates of model parameters, or explicitly as an additional load reduction requirement. Individual errors in model inputs, such as data used for developing model parameters or data used for calibration, may affect the load allocations in a positive or a negative way. The purpose of the MOS is to avoid an overall bias toward load allocations that are too large for meeting the water quality target. An implicit MOS was used in the development of this TMDL through selection of a water quality standard providing a high level of protection, utilization of entire segment volumes for model calculations, averaging extreme high and low values to ensure that the more protective condition with the largest available data set was addressed and emphasizing watershed-based implementation measures.

Recommendations for TMDL Implementation

The goal of this TMDL was to develop an allocation plan that achieves water quality standards during the implementation phase. Virginia's 1997 Water Quality Monitoring, Information and Restoration Act states in section 62.1-44.19.7 that the "Board shall develop and implement a plan to achieve fully supporting status for impaired waters".

The TMDL developed for the Chesapeake Bay: Craddock Creek watershed impairments provides allocation scenarios that will be a starting point for developing implementation strategies. Additional monitoring aimed at targeting the necessary reductions is critical to implementation development. Once established, continued monitoring will aid in tracking success toward meeting water quality milestones.

Public participation is critical to the implementation process. Reductions in non-point source loading is the crucial factor in addressing the problem. These sources cannot be addressed without public understanding of and support for the implementation process. Stakeholder input will be critical from the onset of the implementation process in order to develop an implementation plan that will be truly effective.

Public Participation

During development of the TMDL for the Craddock Creek watershed, public involvement was encouraged through a public participation process that included public meetings and stakeholder meetings.

The first public meeting was held on March 3rd of 2005. A basic description of the TMDL process and the agencies involved was presented and a discussion was held to regarding the source assessment input, bacterial source tracking, and model results. This meeting was followed by development of the final draft TMDL and a review by the stakeholders. These comments were discussed at a technical advisory committee meeting comprised of stake holders on ___________, 2005.

The final model simulations and the TMDL load allocations were presented during the second public meeting held on____________. Public understanding of and involvement in the TMDL process was encouraged. Input from these meetings was utilized in the development of the TMDL and improved confidence in the bacteria allocation scenarios and TMDL process.

1.0 Introduction

This document details the development of bacterial Total Maximum Daily Load (TMDL) for one segment in the Chesapeake Bay: Craddock Creek watershed in Accomack County, Virginia which is listed as impaired on Virginia's 303(d) Total Maximum Daily Load Priority List. The TMDL is one step in a multi-step process that includes a high level of public participation in order to address water quality issues that can affect public health and the health of aquatic life.

Water quality standards are regulations based on federal or state law that set numeric or narrative limits on pollutants. Water quality monitoring is performed to measure these pollutants and determine if the measured levels are with the bounds of the limits set for the uses designated for the waterbody. The waterbodies which have pollutant levels above the designated standards are considered impaired for the corresponding designated use (e.g. swimming, drinking, shellfish harvest, etc.). The impaired waterways are listed on the §303 (d) list reported to the Environmental Protection Agency. Those waters placed on the list require the development of a TMDL intended to remediate the impairment and bring the water into compliance with the designated standards.

TMDLs represent the total pollutant loading that a water body can receive without violating water quality standards. The TMDL process establishes the allowable loading of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. By following the TMDL process, states can establish water quality based controls to reduce pollution from both point and non-point sources to restore and maintain the quality of their water resources (EPA, 1991).

Fecal coliform bacteria are the most common cause for the impairments in Virginia shellfish growing waters. This group of bacteria is considered an indicator of the presence of fecal contamination. The most common member of the fecal coliform group is *Escherichia coli*. Fecal coliforms are associated with the fecal material derived from humans and warm-blooded animals. The presence of fecal coliform bacteria in aquatic environments is an indication that the water may have been contaminated by pathogens or disease-producing bacteria or viruses. Waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis, and hepatitis A. Filter-feeding shellfish can concentrate these pathogens which can be transmitted and cause disease when eaten uncooked. Therefore, the presence of elevated numbers of fecal coliform bacteria is an indicator that a potential health risk exists for individuals consuming raw shellfish. Fecal contamination can occur from point source inputs of domestic sewage or from nonpoint sources of human, (e.g., malfunctioning septic systems) or animal wastes.

Because the fecal coliform indicator does not provide information on the source or origin of fecal contamination, Agencies of the Commonwealth, including the Department of Environmental Quality (DEQ), the Virginia Department of Health – Division of Shellfish sanitation (VDH-DSS) and the Department of Conservation and Recreation (DCR) have worked together with state universities, the U.S. Geological Survey and the U.S. Environmental Protection Agency to develop methods to assess sources of fecal coliforms to assist in development of TMDLs in impaired shellfish waters. As a group these methods are usually called bacterial or microbial source tracking (BST or MST). This study utilizes bacteria source tracking (BST) to determine the most probable sources of fecal coliform bacteria in the waters of Craddock Creek.

water. To assist with the analysis and development of the TMDLs for impaired shellfish waters, the Department of Environmental Quality contracted the Virginia Institute of Marine Science (VIMS) for the early phases of development.

1.2 Overview of the TMDL Development Process

A TMDL study for shellfish waters is the first part of a phased process aimed at restoring water quality. This study is designed to determine how much of the bacterial pollutant input needs to be reduced in order to achieve water quality standards. The second step in the process is the development of an implementation plan that identifies which specific control measures are necessary to achieve those reductions, their timing for implementation and at what cost. The implementation plan will also outline potential funding sources. The third step will be the actual implementation process. Implementation will typically occur in stages that allow a review of progress in reducing pollutant input, refine bacteria loading estimates based upon additional data and to make any identified changes to pollutant control measures.

The TMDL development process also must account for seasonal and annual variations in precipitation, flow, land use, and pollutant contributions. Such an approach ensures that TMDLs, when implemented, do not result in violations under a wide variety of scenarios that affect bacterial loading.

2.0 Applicable Water Quality Standard

Water quality standards are provisions of state or federal law which consist of a designated use or set of uses for the waters and water quality criteria based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.). According to Virginia Water Quality Standards (9 VAC 25-260-5), the term *"water quality standards means provisions of state or federal law which consist of a designated use or uses for the waters of the Commonwealth and water quality criteria for such waters based upon such uses. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the State Water Control Law (§62.1-44.2 et seq. of the Code of Virginia) and the federal Clean Water Act (33 USC §1251 et seq.)."*

2.1 Designated Uses and Criteria

Generally, all tidal waters in Virginia are designated as shellfish waters. The identification of the applicable river reaches can be found in the river basin tables at 9VAC25-260-390 et seq. For a shellfish supporting water body to be in compliance with Virginia bacterial standards, VADEQ specifies the following criteria (9 VAC 25-260-160): " *In all open ocean or estuarine waters capable of propagating shellfish or in specific areas where public or leased private shellfish beds are present, and including those waters on which condemnation or restriction classifications are established by the State Department of Health the following criteria for fecal coliform bacteria shall apply; The geometric mean fecal coliform value for a sampling station shall not exceed an MPN (most probable number) of 14 per 100 milliliters. The 90th percentile shall not exceed an MPN of 43 for a 5 tube, 3 dilution test or 49 for a 3 tube, 3 dilution test."*

2.2 Classification of Virginia's Shellfish Growing Areas

The Virginia Department of Health, Division of Shellfish Sanitation (DSS) is responsible for classifying shellfish waters and protecting the health of bivalve shellfish consumers. The VDH- DSS follows the requirements of the National Shellfish Sanitation Program (NSSP), which is regulated by the U.S. Food and Drug Administration. The NSSP specifies the use of a shoreline survey as its primary tool for classifying shellfish growing waters. Fecal coliform bacteria concentrations in water samples collected in the immediate vicinity of the shellfish beds function to verify the findings of the shoreline survey, and to define the border between approved and condemned (unapproved) waters. Much of the DSS effort is focused on locating fecal contamination, and in this manner minimizing the introduction of human pathogens into shellfish waters.

DSS designs and operates the shoreline survey to locate sources of pollution within the watersheds of shellfish growing areas. This is accomplished through a property-by-property inspection of the onsite sanitary waste disposal facilities of most properties on un-sewered sections of watersheds, and investigations of other sources of pollution such as wastewater treatment plants (WTP), marinas, livestock operations, landfills, etc. The information is compiled into a written report with a map showing the location of the sources of real or potential pollution found and sent to the various agencies that are responsible for regulating these concerns in the city or county. Once an onsite problem is identified, local health departments (LHDs), and/or other state and local agencies may play a role in the process of correcting the deficiencies.

The VDH-DSS collects monthly seawater samples at over 2,000 stations in the shellfish growing areas of Virginia. Though they continuously monitor sample data for unusual events, they formally evaluate shellfish growing areas on an annual basis. The annual review uses data from the most recent 30 samples (typically 30 months), collected randomly with respect to weather. The data are assessed to determine whether the water quality standards are met. If the water quality standards are exceeded, the shellfish area is closed for the harvest of shellfish that go directly to market. Those areas that marginally exceed the water quality standard and are closed for the direct marketing of shellfish are eligible for harvest of shellfish under permit from the Virginia Marine Resources Commission and VDH-DSS. The permit establishes controls that in part require shellfish be allowed to depurate for 15 days in clean growing areas or specially designed licensed on shore facilities. Shellfish in growing areas that may be highly polluted, such as those in the immediate vicinity of a wastewater treatment facility (prohibited waters), are not allowed to be moved to clean waters for self purification.

3.0 Watershed Characterization

The Craddock Creek watershed is located entirely within Accomack County. The condemnation in the watershed is identified as condemnation 195 consisting of the uppermost tidal portions of Craddock Creek. The condemnation notice can be found in Appendix A. The watershed occupies a landscape position along the eastern shore of the Chesapeake Bay (Figure 3.0). The watershed is bounded on the west by the Chesapeake Bay, rural route 614 on Craddock Neck to the north and rural route 613 on Scarborough Neck to the south and route 615 to the east. The drainage area of the Chesapeake Bay: Craddock Creek watershed is approximately 6.5 square miles. Population estimated by the 2000 US Census is 501.

Figure 3.0

Location Map of Craddock Creek, Accomac County, Virginia

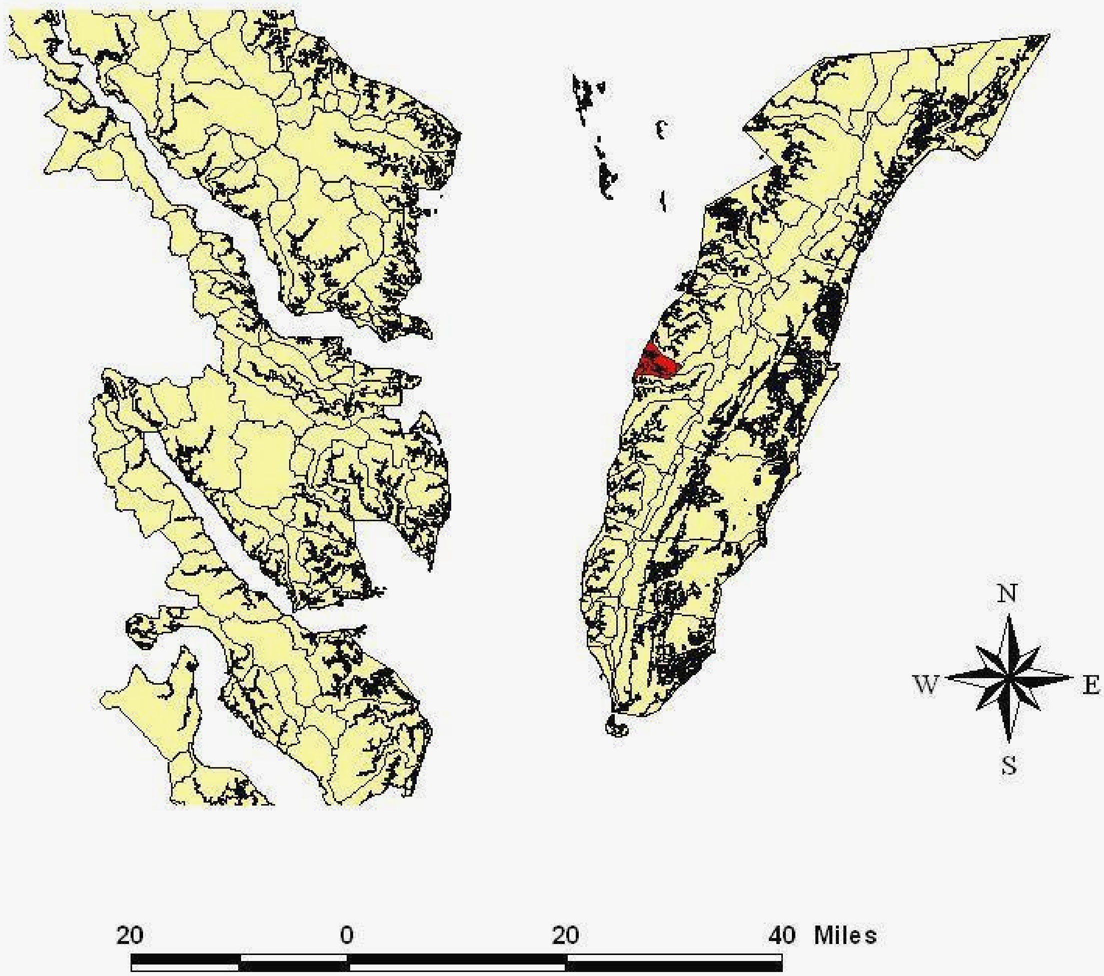


Figure 3.1

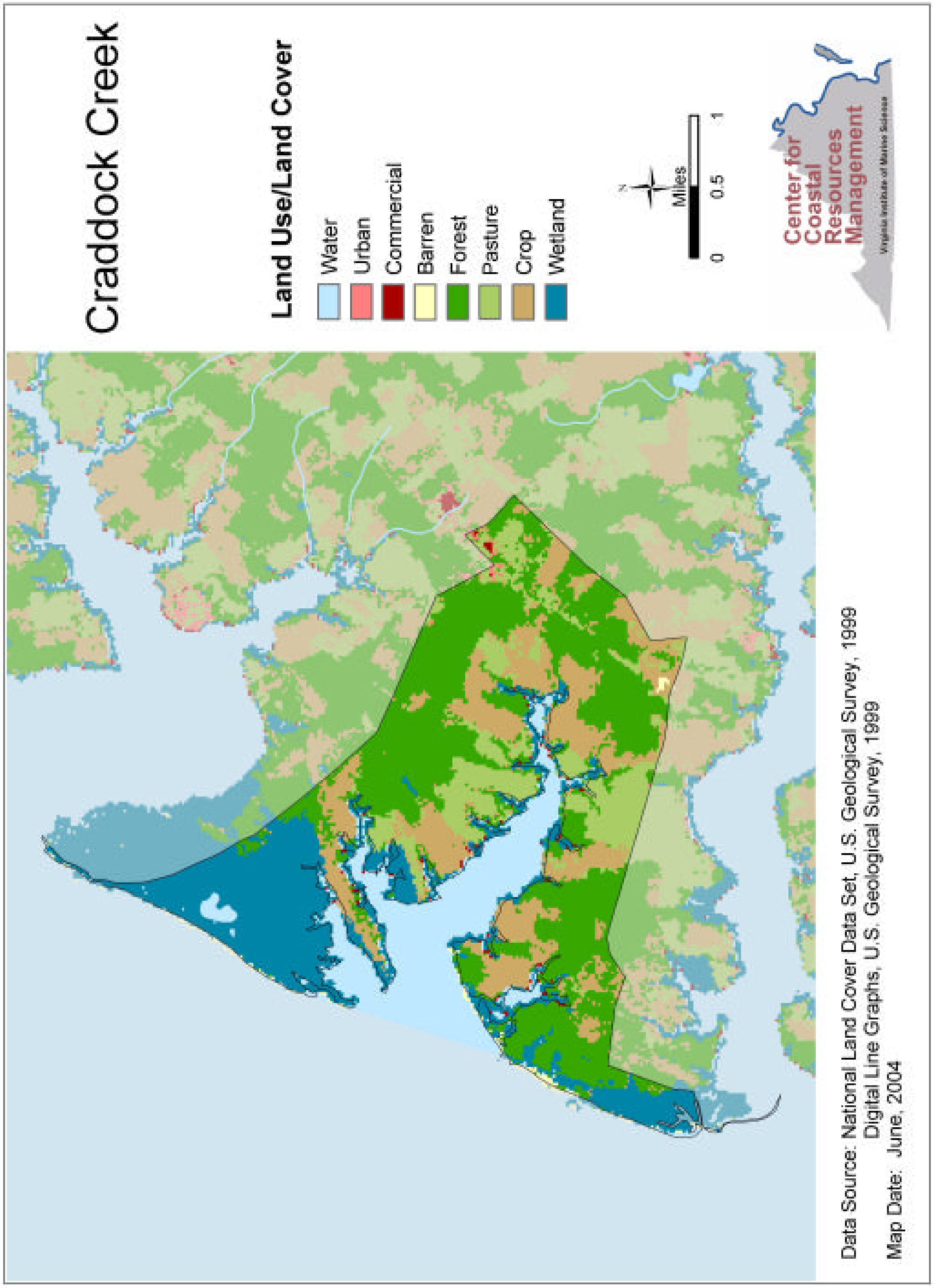
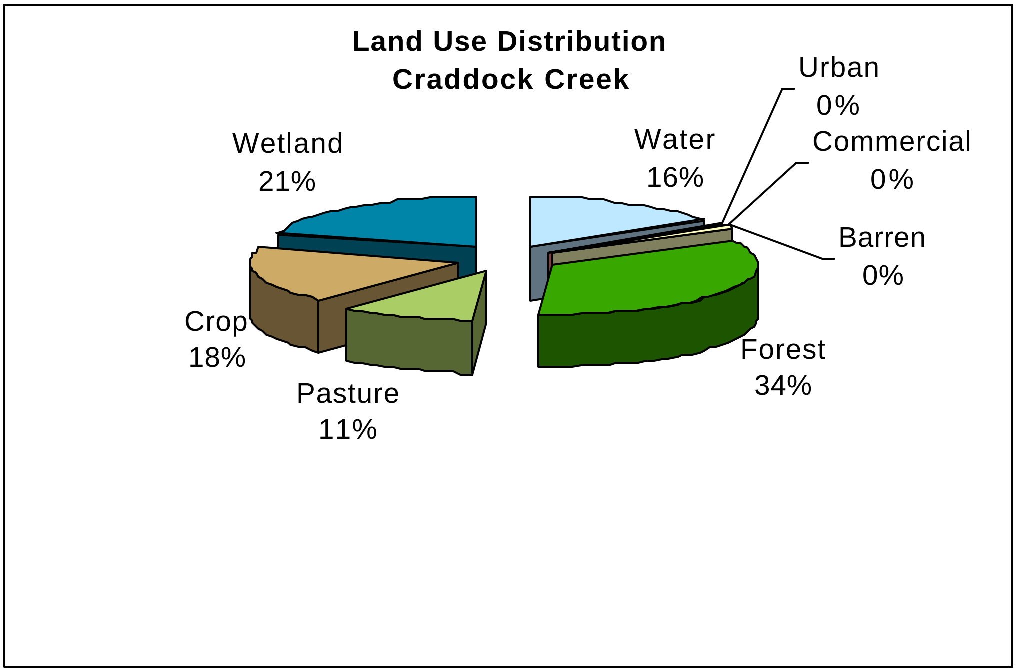

Craddock Creek
Land Use/Land Cover
Water
Urban
Commercial
Barren
Forest
Pasture
Crop
Wetland
N
Miles
0
0.5
1
Center for Coastal Resources Management
Virginia Institute of Marine Science
Data Source: National Land Cover Data Set, U.S. Geological Survey, 1999
Digital Line Graphs, U.S. Geological Survey, 1999
Map Date: June, 2004

Figure 3-2



A map of the land use in the watershed is shown in Figure 3-1. Almost half of the land use in the watershed is undeveloped forest and wetland (See Figure 3-2). Agriculture uses are the next most prevalent category with cropland exceeding pasture. Developed lands, termed urban and commercial, occupy less than 1% of the landscape. Estimations of the populations of livestock and wildlife, as well as numbers of septic systems within the watershed are shown in Table 3-1. Appendix B: Supporting Documentation and Watershed Assessment, provides a description of data and list of data sources.

Table 3-1 Animal Populations and Septic Systems Growing Area 83

Fecal Coliform Sources	Craddock Creek: Rescinded CA 195 A	Craddock Creek: Condemnation 195B
Cattle	1	4
Chicken	10456	34865
Deer	16	57
Dog	15	51
Duck	127	217
Geese	87	150
Horse	0	1
Pig	2	8
Raccoon	26	46
Sheep	0	1
Septic	25	88

4.0 Water Quality Impairment and Bacterial Source Assessment

4.1 Water Quality Monitoring

The water quality monitoring network consists of 10 monitoring stations. These stations are monitored by the VDH-DSS for fecal bacteria. The locations of the water quality monitoring stations are shown in Figure 4.1. This TMDL study examined bacterial monitoring data at these stations for a period of time from 1995 through August 2003. A summary of water quality data for the monitoring period preceding the TMDL study is shown in Table 4.1. Graphs depicting the geometric mean and 90th percentile geometric mean are shown in Figure 4.3A. In Table 4.1, a station outside the closure area(s) that shows a maximum value for either the geometric mean, 90th percentile, or both that exceeds the standard, may be due to the inclusion of data collected after 1998. This may provide an indication of water quality issues in the watershed since the time of the 1998 impaired waters listing of areas in this watershed. Only data for those stations associated with a condemnation from 1998, as indicated by a condemnation number in Table 4.1 are used for the TMDLs in this study.

The closure in the growing area is characterized based on all monitoring stations (see Figure 4-1) in the closed area. To facilitate an effective assignment of the appropriate level of protection for this system, the water quality data were averaged across all stations in the condemned area. This treats high and low values equally and provides a target that can be easily comprehended and uniformly implemented while retaining the necessary protection for the affected waters.

4.2 Condemnation Areas

One segment in Craddock Creek was listed as impaired on Virginia's 1998 303(d) water quality standard for fecal coliform bacteria in shellfish supporting waters. Detailed maps of the shellfish condemnation area and its associated water quality stations are available from the Virginia Department of Health, Division of Shellfish Sanitation. A map of the condemnation areas is shown in Figure 4.2. Copies of the condemnation notices may be found in Appendix A.

4.3 Fecal Coliform Bacteria Source Assessment

The locations of shoreline deficiencies from the DSS shoreline survey and wastewater treatment facilities (if any), are shown in Figure 4.4.

<u>A. Point Source</u>

As indicated in Figure 4.4, there are no VPDES permitted wastewater treatment plant point source contributions to the watershed.

Figure 4.1

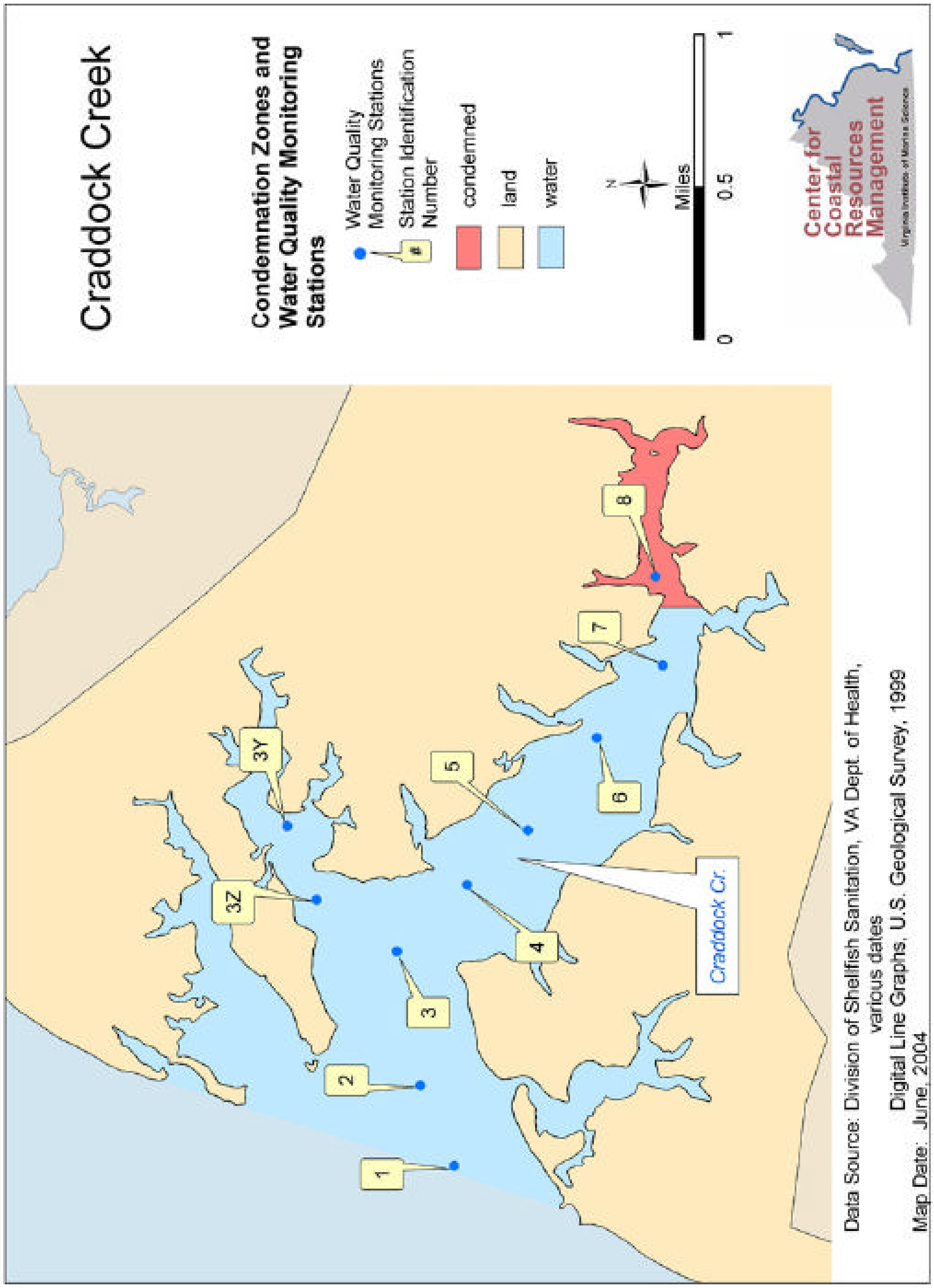

Craddock Creek
Condemnation Zones and Water Quality Monitoring Stations
Water Quality Monitoring Stations
Station Identification Number
condemned
land
water
N
Miles
0
0.5
1
Center for Coastal Resources Management
Virginia Institute of Marine Science
1
2
3
3Z
3Y
4
5
6
7
8
Craddock Cr.
Data Source: Division of Shellfish Sanitation, VA Dept. of Health, various dates
Digital Line Graphs, U.S. Geological Survey, 1999
Map Date: June, 2004

Figure 4.2

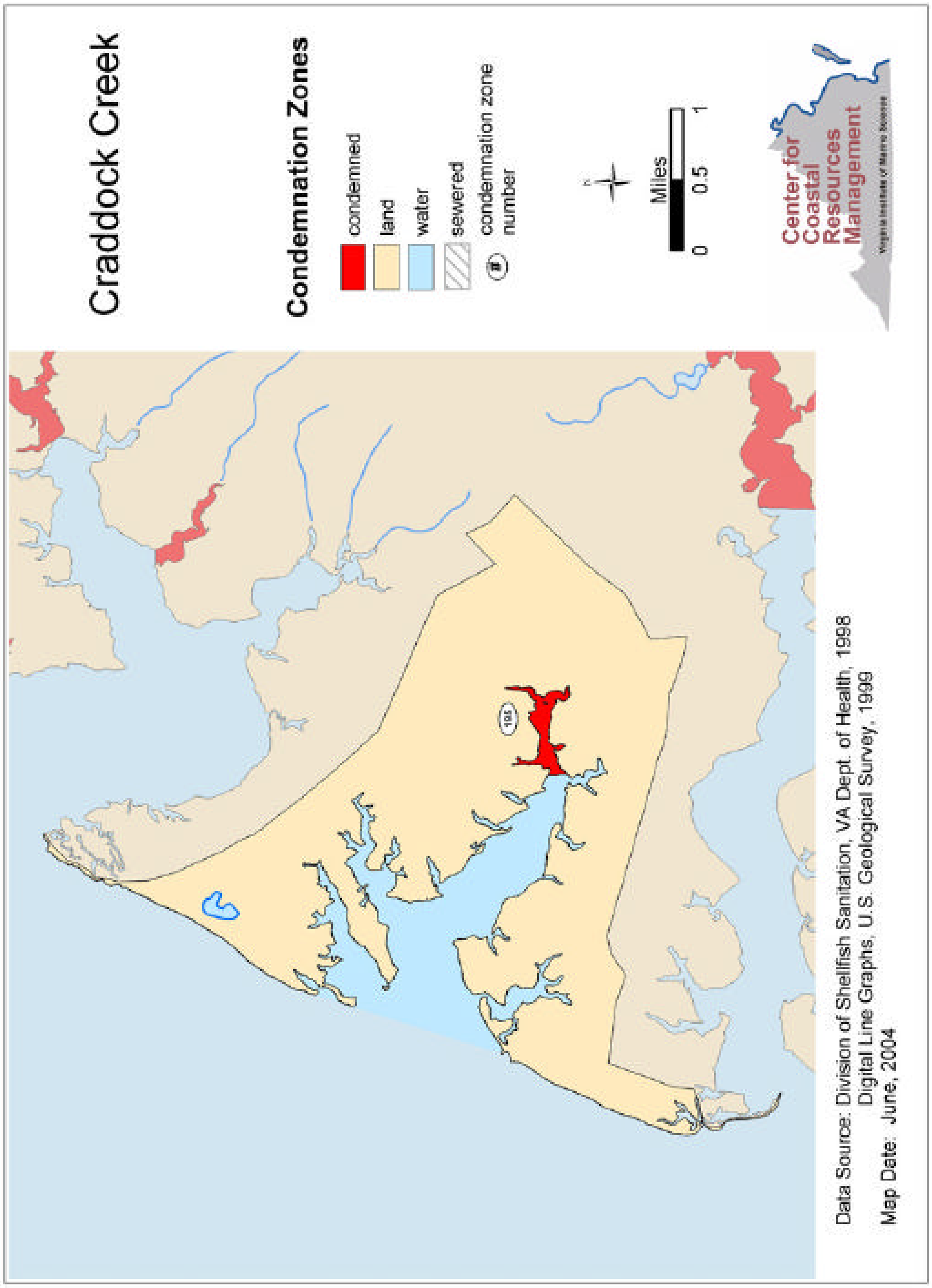
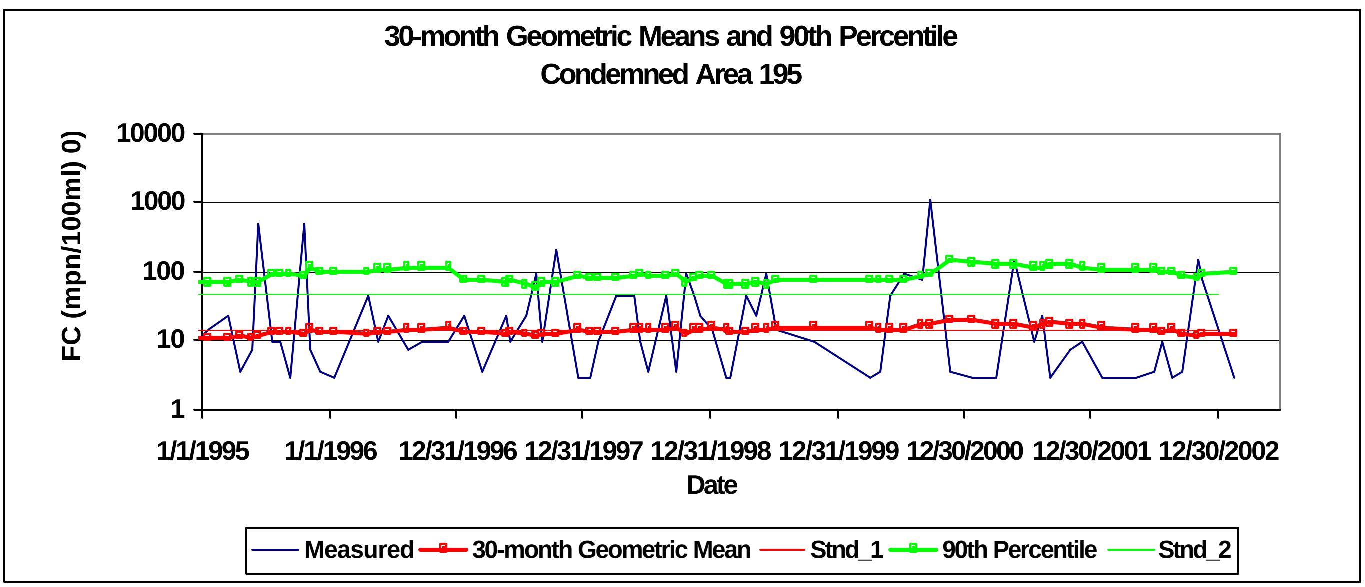

Craddock Creek
Condemnation Zones
condemned
land
water
sewered
condemnation zone number
Miles
0
0.5
1
Center for Coastal Resources Management
Virginia Institute of Marine Science
Data Source: Division of Shellfish Sanitation, VA Dept. of Health, 1998
Digital Line Graphs, U.S. Geological Survey, 1999
Map Date: June, 2004

Table 4-1 Water Quality Data Summary: Growing Area 83 Craddock Creek

Station	Condemnation Area	Total Observations	Geometric Mean	Station Violates Geometric Standard: 14 MPN	90th Percentile	Station Violates 90th Percentile Standard: 49 MPN
83-1		102	3.3	No	5.6	No
83-2		156	3.7	No	8.6	No
83-3		101	3.9	No	10.0	No
83-3Y	195A	102	8.4	No	41.4	No
83-3Z		156	5.4	No	18.1	No
83-4		156	4.1	No	11.4	No
83-5		101	4.2	No	11.2	No
83-6		156	4.6	No	12.0	No
83-7		153	6.8	No	25.3	No
83-8	195B	149	20.2	Yes	140.3	Yes

Figure 4.3A



C. Non-Point Source Contributions

Nonpoint sources of fecal coliform do not have one discharge point but may occur over the entire length of the receiving water. Fecal coliform bacteria deposited on the land surface can build up over time. During rain events, surface runoff transports water and sediment and discharges to the waterway. Sources of fecal coliform bacteria include grazing livestock, concentrated animal feeding operations, land application of manure and wildlife and pet excrement. Direct contribution to the waterway occurs when livestock or wildlife defecate into or immediately adjacent to receiving waters. Nonpoint source contributions from humans generally arise from failing septic systems and associated drain fields, moored or marina vessel discharges, storm water management facilities, pump station failures and ex-filtration from sewer systems. Contributions from wildlife, both mammalian and avian, are natural conditions and may represent a background level of bacterial loading. There is only a small portion of the watershed in the south-eastern end on sewer. It is therefore likely that human loading is due to failures in septic waste treatment systems and/or pollution from recreational vessel discharges.

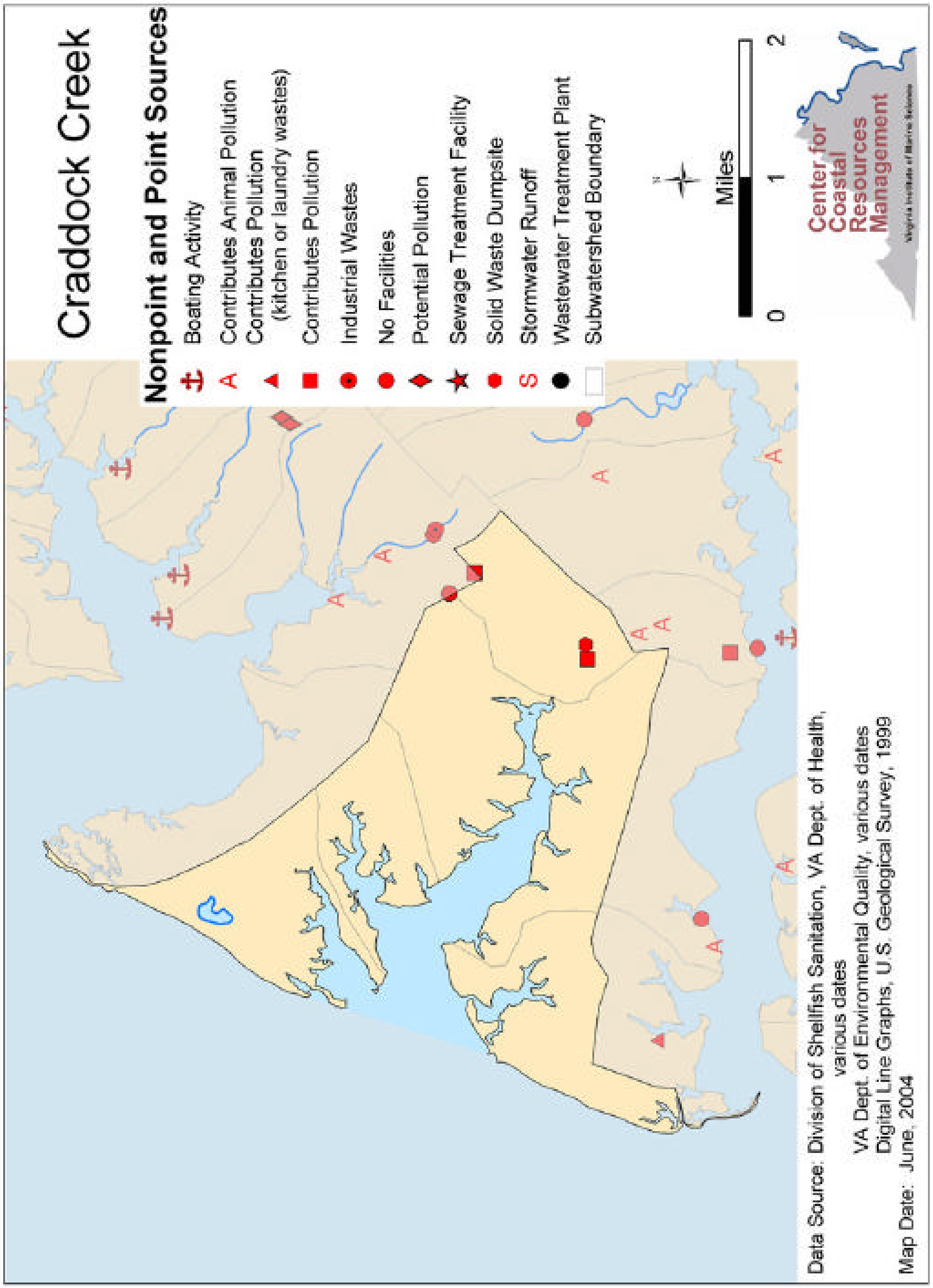
The shoreline survey is used as a tool to identify nonpoint source contribution problems and locations. Figure 4.4 shows the results of the DSS sanitary shoreline survey dated April 20, 2004. A copy of the textual portion of this survey has been included as Appendix A. The survey identified 2 potential sources. One was related to an animal pen within 75 feet of a receiving water, and the second was from a trash dumpster. The dumpster was listed as being regularly maintained and emptied.

4.4 Bacterial Source Tracking

Bacterial Source tracking is used to identify sources of fecal contamination from human as well as domestic and wild animals. The BST method used in Virginia is based on the premise that *Escherichia coli (E. Coli)* found in human, domestic animals, and wild animals will have significantly different patterns of resistance to a variety of antibiotics. The Antibiotic Resistance Approach (ARA), uses fecal streptococcus or *E. coli* and patterns of antibiotic resistance for separation of sources of the bacterial contribution. The BST analysis method used for this TMDL classified the bacteria into one of four source categories: human, pets, livestock, and wildlife. However, BST analysis is an experimental, not approved, scientific technique that is under evaluation and the error involved in correctly assigning *E. coli* isolates to the appropriate fecal sources is unknown. That said BST is still the best scientific tool available to focus on the probable sources of bacterial contamination to the watershed.

Figure 4.1 shows the TMDL study stations, a subset of which are the BST monitoring stations for Craddock Creek Growing Area. The data developed for the watershed show that the dominant contribution in Craddock Creek, Condemnation 195 is wildlife followed by human bacteria. Human sources and pet sources are equally dominant. Figures 4.5A and B show the mean distribution by month for these bacteria the source categories and the annual means are shown in Figure 4.6. The BST sampling period was October 2002 through August 2003. The target sampling interval was once monthly, if the graph does not show 11 months, that means that there were months for which data was not available. This data is shown in tabular form in Table 4.2. These values are used for the source allocation in deriving the Total Maximum Daily Loads for Craddock Creek

Figure 4.4



Craddock Creek
Nonpoint and Point Sources
Boating Activity
Contributes Animal Pollution
Contributes Pollution
(kitchen or laundry wastes)
Contributes Pollution
Industrial Wastes
No Facilities
Potential Pollution
Sewage Treatment Facility
Solid Waste Dumpsite
Stormwater Runoff
Wastewater Treatment Plant
Subwatershed Boundary
Miles
0
1
2
Center for Coastal Resources Management
Data Source: Division of Shellfish Sanitation, VA Dept. of Health, various dates
VA Dept. of Environmental Quality, various dates
Digital Line Graphs, U.S. Geological Survey, 1999
Map Date: June, 2004

Figure 4.5A

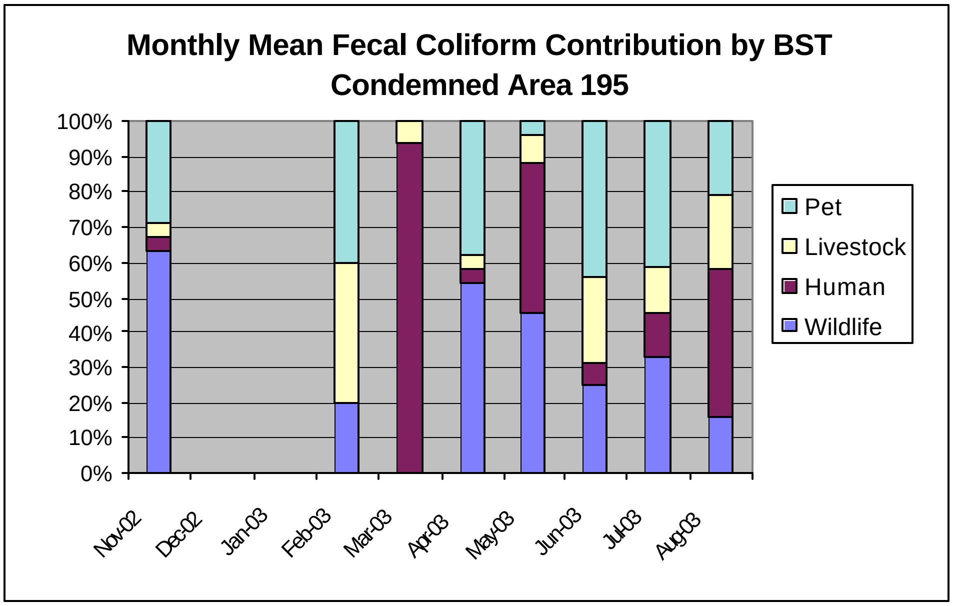


Figure 4.5 B

*** Closure Rescinded Data Presented for Information Only**

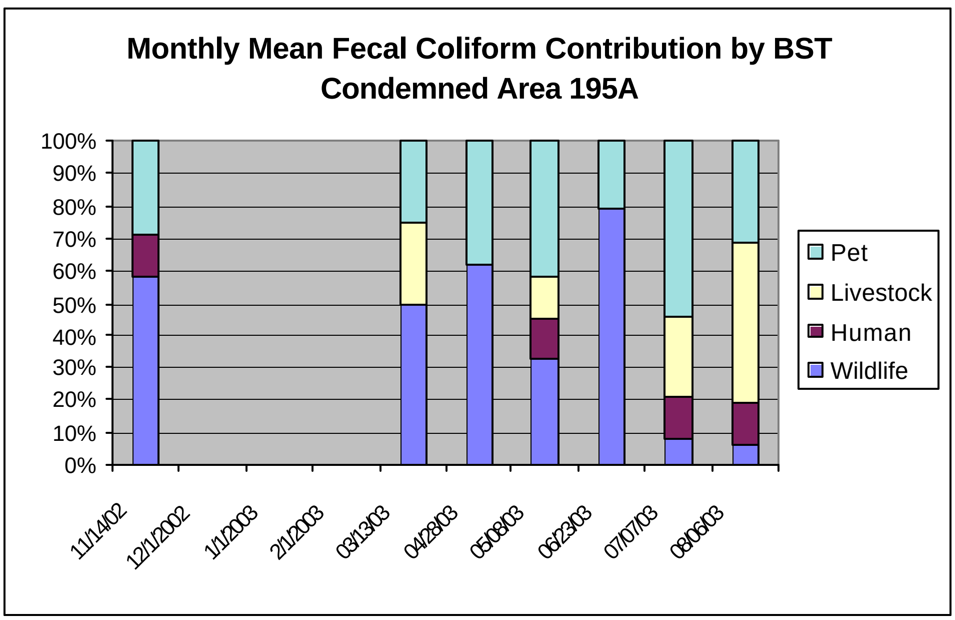


Figure 4.6

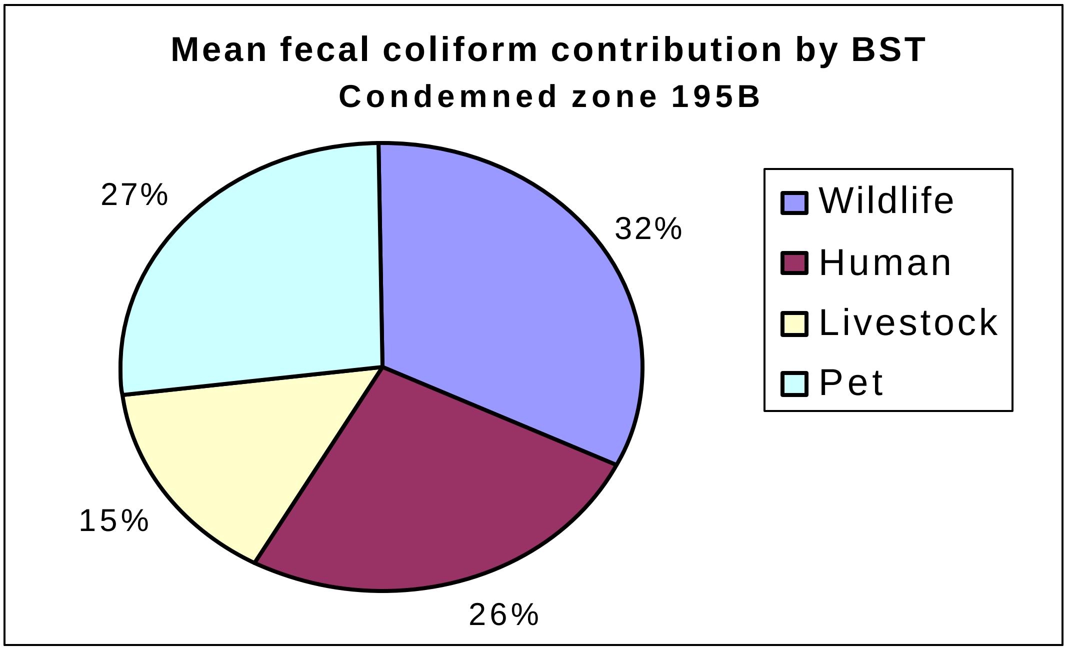


Table 4.2 Non-point Source Load Distribution using BST
Growing area 83: Chesapeake Bay: Craddock Creek

Condemnation Area	Livestock	Wildlife	Human	Pet
195 Craddock Creek	**15%**	**32%**	**26%**	**27%**

5.0 TMDL Development

5.1 Steady-State Modeling Approach

Bay and coastal waters are subject to the action of the tides. The ebb and flood of the tide serves to move water between locations exchanging and mixing the water. The tide and amount of freshwater discharge into the embayment are the dominant influences on the transport of fecal coliform. The TMDL is calculated using the steady-state tidal prism model. Compared to the volumetric method (EPA Shellfish Workshop, 2002), the steady-state tidal prism model incorporates the influences of tidally induced transport, freshwater input, and removal of fecal coliform via decay. The model assumes that the embayment is well mixed, and freshwater input, tidal range, and the first-order decay of fecal coliform are all constant. A detailed description of the model is presented in

Appendix B, and a summary is presented below.

The steady-state tidal prism model calculates fecal coliform load using equation (1):

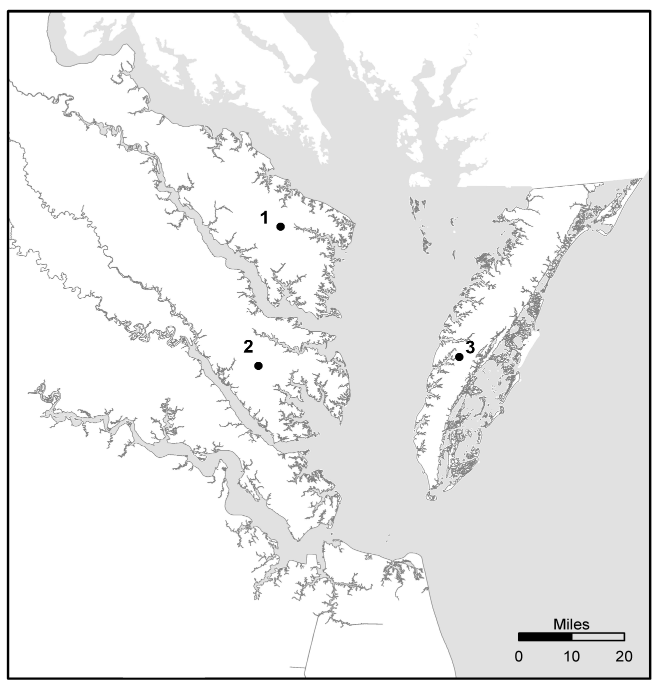
$$L = [C(Q_b + kV) - Q_0 C_0] \times Cf \quad (1)$$

where:
L = fecal coliform load (counts per day)
C = mean fecal coliform concentration (MPN /100ml) of embayment
k = the fecal coliform removal/decay rate (per day)
C_0 = the fecal coliform concentration (MPN/100ml) at the ocean boundary
Q_0 = the quantity of water that enters the embayment on the flood tide through the ocean boundary that did not flow out of the embayment on the previous ebb tide (m^3 per tidal cycle)
Q_b = the quantity of mixed water that leaves the embayment on the ebb tide that did not enter the embayment on the previous flood tide (m^3 per tidal cycle)
V = the mean volume of the embayment (m^3) and
Cf = the unit conversion factor.
Q_b and Q_0 are estimated based on the steady state condition as follows:

$$Q_b = Q_0 + Q_f$$

$$Q_0 = bQ_T$$

where b is an exchange ratio and Q_T is the total ocean water entering the bay on the flood tide, which is calculated based on tidal range. The dominant tide in this region is the lunar semi-diurnal (M_2) tide with a tidal period of 12.42 hours. Therefore, the M_2 tide is used for the representative tidal cycle. In general, the exchange ratio varies from 0.3 to 0.7, based on the previous model tests in Virginia coastal embayments (Kuo et al., 1998; Shen et al., 2002). A mean value of 0.5 was used for the exchange ratio. Q_f is mean freshwater discharge during the tidal cycle. The stream flow used for Q_f was based on a ratio of the drainage area of the subject watershed as compared to the drainage area and the stream flows measured by the U.S. Geological Survey for one of the three gauging stations; Great Wicomico, Ware River and Nassawaddox Creek. The Nassawaddox Creek was used for this study.



Map Number	USGS gaging station	Stream Name
1	01661800	Great Wicomico River
2	01670000	Ware River
3	01844800	Nassawaddox Creek

The selection of gauging station for use in the model is determined by the proximity of the station to the TMDL study area

5.2 The TMDL Calculation

To meet the water quality standards for both geometric mean and 90th percentile criteria, TMDLs for the impaired segments in the watershed are defined for the geometric mean load and the 90th percentile load. The TMDL for the geometric mean essentially represents the allowable average limit and the TMDL for the 90th percentile is the allowable upper limit. If observed data were available for more than one monitoring station in a condemned area, the volume-weighted values for each condemned area were used to represent the embayment concentration.

A. Current Fecal Coliform Condition

The fecal coliform concentration in an embayment varies due to the changes in biological, hydrological and meteorological conditions. The current condition was determined based on the 30-sample geometric mean and 90th percentile of volume-weighted fecal coliform values of each condemned area. The period of record for the monitoring data used to determine the current condition is 1995 to 2002. This interval was chosen to ensure inclusion of the data that represents the conditions at the time the waters were first listed as impaired in 1998. As the regulatory requirement for assessment is based upon 30 (month) sample intervals and the waters were first listed as impaired in 1998, the current condition has been determined using monitoring data for that time interval of 3 years preceding the 1998 list date to the time of the BST analysis. The maximum values for geometric mean and 90th percentile were used to represent the current loads. Therefore, the current loads represent the worse case scenario.

B. Geometric Mean Analysis:

The current 30-sample geometric mean was used for the load estimation. The corresponding 30-sample geometric mean from the station outside the condemned area was used as the boundary condition. The current load was estimated using steady state tidal prism model. The allowable load was calculated using the water quality standard of 14 MPN/100ml. This value was also used as boundary condition for the calculation. The load reduction needed for the attainment of the water quality standard was determined by subtracting the allowable load from the current load. The process may be described by the word equation as follows. The calculated results are listed in Table 5-2.

The load reduction is estimated as follows:

Geometric Mean Value (X MPN/100ml) x (volume) = Current Load

Criteria Value (14 MPN/100ml) x (volume) = Allowable Load

$$\textbf{Load Reduction} = \frac{\textbf{Current Load} - \textbf{Allowable Load}}{\textbf{Current Load}} \times 100\ \%$$

Table 5.1 Geometric Mean Analysis of Current Load and Estimated Load Reduction

Geometric Mean Calculation for Growing Area 195							
Condemnation Area	Volume (m^3)	Fecal Coliform (MPN/100ml)	Decay Rate (1/day)	Residence Time (day)	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
195	75150	20.21	0.35	1.2	2.54E+10	6.74E+09	73.4

C. 90th Percentile Analysis

The current 30-sample 90th percentile concentration was used for the current load estimation. The corresponding 30-sample geometric mean from the station outside the condemned area was used as the boundary condition. The current load was estimated using steady state tidal prism model. The allowable load was calculated based on the water quality standard of 49 MPN/100ml. This value was also used as boundary condition for the calculation. The calculated results are listed in Table 5-3.
The load reduction is estimated as follows:

$$\text{Load Reduction} = \frac{\text{Current Load} - \text{Allowable Load}}{\text{Current Load}} \times 100\ \%$$

Table 5.2 90th Percentile Analysis of Current Load and Estimated Load Reduction

90th Percentile Calculation for Growing Area 195							
Condemnation Area	Volume (m^3)	Fecal Coliform (MPN/100mL)	Decay Rate (1/day)	Residence Time (day)	Current Load (MPN/day)	Allowable Load (MPN/day)	Required Reduction (%)
195	75150	140.34	0.35	1.2	1.98E+11	2.36E+10	88.1

5.3 Load Allocation

A comparison of the reductions based on geometric mean load and on the 90th percentile load shows that the 90th percentile load is the critical condition. This is consistent with water quality analysis. The 90th percentile criterion is most frequently exceeded. Therefore the 90th percentile loading is used to allocate source contributions and establish bacteria load reduction targets among the various contributing sources that will yield the necessary water quality improvements to attain the water quality standard.

Based on source assessment of the watershed, the percent loading for each of the major source categories is estimated. These percentages are used to determine where load reductions are needed. The loadings for each source are determined by multiplying the total current and allowable bacteria loads by the representative percentage. The percent reduction needed to attain the water quality standard or criterion is allocated to each bacteria source category. This is shown in Table 5-4 and serves to fulfill the TMDL requirements by ensuring that the criterion is attained.

Table 5.3 Reduction and Allocation Based Upon 90th Percentile Standard: Growing Area 83

Condemnation Area		BST Allocation % of Total Load	Current Load MPN/ day	Load Allocation MPN/ day	Reduction Needed
195 Craddock Creek	Livestock	15	2.97E+10	0.00E+00	100.0%
	Wildlife	32	6.34E+10	2.36E+10	62.8%
	Human	26	5.15E+10	0.00E+00	100.0%
	Pets	27	5.35E+10	0.00E+00	100.0%
	Total	100	**1.98E+11**	**2.36E+10**	**88.1**

The TMDL seeks to eliminate 100% of the human derived fecal bacteria component regardless of the allowable load determined through the load allocation process. Human derived fecal coliforms are a serious concern in the estuarine environment and discharge of human waste is precluded by state and federal law. According to the preceding analysis, reduction of the controllable loads; human, livestock and pets, will result in achievement of the water quality standard for condemned area 195. Absent any other sources, the reduction is allocated to wildlife. Through an iterative implementation of actions to reduce the controllable loads, subsequent monitoring may indicate that further reductions are not necessary, or that revisions in implementation strategies may be appropriate. Continued violations may result in the process of Use Attainment Analysis, UAA, for the waterbody (see Chapter 6 for a discussion of UAA). The allocations presented demonstrate how the TMDLs could be implemented to achieve water quality standards; however, the state reserves the right to allocate differently, as long as consistency with the achievement of water quality standards is maintained.

5.3.1 Development of Wasteload Allocations

There are no permitted point source discharges in the watershed that affect the shellfish waters examined under this TMDL. No wasteload allocation is considered in this TMDL.

5.4 Consideration of Critical Conditions and Seasonal Variation

EPA regulations at 40 CFR 130.7 (c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the waterbody is protected during times when they are most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards. The current loading to the waterbody was determined using a long-term record of water quality monitoring (observation) data. The period of record for the data was 1995 to 2002. The resulting estimate is quite robust.

A comparison of the geometric mean values and the 90th percentile values against the water quality criteria will determine which represents the more critical condition or higher percent reduction. If the geometric mean values dictate the higher reduction, this suggests that, on average, water sample counts are consistently high with limited variation around the mean. If the 90th percentile criterion requires a higher reduction, this suggests an occurrence of the high fecal coliform due to the variation of hydrological conditions. For this study, the 90th percentile criterion is the most critical condition. Thus, the final load reductions determined using the 90th percentile represent the most stringent conditions and it is the reductions based on these bacterial loadings that will yield attainment of the water quality standard. Seasonal variations involve changes in surface runoff, stream flow, and water quality as a result of hydrologic and climatologic patterns. Variations due to changes in the hydrologic cycle as well as temporal variability in fecal coliform sources, such as migrating duck and goose populations are accounted for by the use of the long-term data record to estimate the current load.

5.5. Margin of Safety

A Margin of Safety (MOS) is required as part of a TMDL in recognition of uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection.

A sensitivity analysis of the model parameters indicates that fecal coliform decay rate is the most sensitive of the model parameters. The decay rate is a lumped parameter that includes die-off due to temperature, salinity, and light. It also includes the influence of re-suspension and other factors. The value of the decay rate varies from between 0.3 and 3.0 in salt water (Thomann and Mueller, 1987). A value of 0.35 per day was used in the TMDL calculation consistent with other regulatory programs. The selected decay rate is a conservative estimate in the TMDL calculation. Therefore, the MOS is implicitly included in the calculation.

5.6 TMDL Summary

To meet the water quality standards for both geometric mean and 90th percentile criteria, TMDLs for Chesapeake Bay: Craddock Creek are defined for the geometric mean load and the 90th percentile load. The TMDLs are summarized in the Tables 5.4 and 5.5.

Table 5.4 TMDL Summary for the Closure in the Craddock Creek Watershed (geometric mean)

Condemnation Area	Pollutant Identified	TMDL MPN/day	Waste Load Allocation MPN/day	Load Allocation MPN/day	Margin of Safety
195	Fecal Coliform	6.74E+09	N/A	6.74E+09	Implicit

Table 5.5 TMDL Summary for the Closure in the Craddock Creek Watershed (90th percentile)

Condemnation Area	Pollutant Identified	TMDL MPN/day	Waste Load Allocation MPN/day	Load Allocation MPN/day	Margin of Safety
195	Fecal Coliform	2.36E+10	N/A	2.36E+10	Implicit

6.0 TMDL Implementation

The goal of the TMDL program is to establish a three-step path that will lead to attainment of water quality standards. The first step in the process is to develop TMDLs that will result in meeting water quality standards. This report represents the culmination of that effort for the bacteria impairments in the Chesapeake Bay: Craddock Creek watershed. The second step is to develop a TMDL implementation plan. The final step is to implement the TMDL implementation plan, and to monitor water quality to determine if water quality standards are being attained.

Once a TMDL has been approved by EPA, measures must be taken to reduce pollution levels in the waterbody. These measures, which can include the use of better treatment technology and the installation of best management practices (BMPs), are implemented in an iterative process that is described along with specific BMPs in the implementation plan. The process for developing an implementation plan has been described in the recent "TMDL Implementation Plan Guidance Manual", published in July 2003 and available upon request from the DEQ and DCR TMDL project staff or at the DEQ website http://www.deq.virginia.gov/tmdl/implans/ipguide.pdf . With successful completion of implementation plans, Virginia will be well on the way to restoring impaired waters and enhancing the value of this important resource. Additionally, development of an approved implementation plan will improve a locality's chances for obtaining financial and technical assistance during implementation.

6.1 Staged Implementation

In general, Virginia intends for the required reductions to be implemented in an iterative process that first addresses those sources with the largest impact on water quality. For example, in agricultural areas of the watershed, the most promising management practice is livestock exclusion from streams and waterbodies. This has been shown to be very effective in lowering fecal coliform concentrations in waterbodies, both by reducing the cattle direct deposits themselves and by providing additional riparian buffers.

Additionally, in both urban and rural areas, reducing the human fecal bacteria loading from failing septic systems should be a primary implementation focus because of its health implications. This component could be implemented through education on septic tank pump-outs as well as a septic system repair/replacement program and the use of alternative waste treatment systems. In urban areas, reducing the loading from leaking sewer lines could be accomplished through a sanitary sewer inspection and management program.

The iterative implementation of BMPs in the watershed has several benefits:

1. It enables tracking of water quality improvements following BMP implementation through follow-up monitoring;
2. It provides a measure of quality control, given the uncertainties inherent in computer simulation modeling;
3. It provides a mechanism for developing public support through periodic updates on BMP implementation and water quality improvements;
4. It helps ensure that the most cost effective practices are implemented first; and
5. It allows for the evaluation of the adequacy of the TMDL in achieving water quality standards.

Watershed stakeholders will have opportunity to participate in the development of the TMDL implementation plan. Specific goals for BMP implementation will be established as part of the implementation plan development.

6.2 Link to ongoing Restoration Efforts

Implementation of this TMDL will contribute to on-going water quality improvement efforts aimed at restoring water quality in the Chesapeake Bay. A tributary strategy has been developed for the Chesapeake Bay Basin. Up-to-date information on tributary strategy development can be found at http://www.snr.virginia.gov/Initiatives/TributaryStrategies/rappahannock.cfm.

6.3 Reasonable Assurance for Implementation

6.3.1 Follow-Up Monitoring

VDH-DSS will continue sampling at the established bacteriological monitoring stations in accordance with its shellfish monitoring program. VADEQ will continue to use data from these monitoring stations and related ambient monitoring stations to evaluate improvements in the bacterial community and the effectiveness of TMDL implementation in attainment of the bacterial water quality standard.

6.3.2. Regulatory Framework

While section 303(d) of the Clean Water Act and current EPA regulations do not require the development of TMDL implementation plans as part of the TMDL process, they do require reasonable assurance that the load and wasteload allocations can and will be implemented. Additionally, Virginia's 1997 Water Quality Monitoring, Information and Restoration Act (the "Act") directs the State Water Control Board to "develop and implement a plan to achieve fully supporting status for impaired waters" (Section 62.1-44.19.7). The Act also establishes that the implementation plan shall include the date of expected achievement of water quality objectives, measurable goals, corrective actions necessary and the associated costs, benefits and environmental impacts of addressing the impairments. EPA outlines the minimum elements of an approvable implementation plan in its 1999 "Guidance for Water Quality-Based Decisions: The TMDL Process." The listed elements include implementation actions/management measures, timelines, legal or regulatory controls, time required to attain water quality standards, monitoring plans and milestones for attaining water quality standards.

Once developed, DEQ intends to incorporate the TMDL implementation plan into the appropriate Water Quality Management Plan (WQMP), in accordance with the Clean Water Act's Section 303(e). In response to a Memorandum of Understanding (MOU) between EPA and DEQ, DEQ also submitted a draft Continuous Planning Process to EPA in which DEQ commits to regularly updating the WQMPs. Thus, the WQMPs will be, among other things, the repository for all TMDLs and TMDL implementation plans developed within a river basin.

6.3.3. Implementation Funding Sources

One potential source of funding for TMDL implementation is Section 319 of the Clean Water Act. Section 319 funding is a major source of funds for Virginia's Non-point Source Management Program. Other funding sources for implementation include the U.S. Department of Agriculture's Conservation Reserve Enhancement and Environmental Quality Incentive Programs, the Virginia State Revolving Loan Program, and the Virginia Water Quality Improvement Fund. The TMDL Implementation Plan Guidance Manual contains additional information on funding sources, as well as government agencies that might support implementation efforts and suggestions for integrating TMDL implementation with other watershed planning efforts.

6.3.4 Addressing Wildlife Contributions

In some waters for which TMDLs have been developed, water quality modeling indicates that even after removal of all of the sources of bacteria (other than wildlife), the stream will not attain standards under all flow regimes at all times. **However, neither the Commonwealth of Virginia, nor EPA are**

proposing the elimination of wildlife to allow for the attainment of water quality standards. This is obviously an impractical and wholly undesirable action. While managing over-populations of wildlife remains as an option to local stakeholders, the reduction of wildlife or changing a natural background condition is not the intended goal of a TMDL.

Based on the above, EPA and Virginia have developed a TMDL strategy to address the wildlife issue. The first step in this strategy is to develop a reduction goal For bacteria. The pollutant reductions for the interim goal are applied only to controllable, anthropogenic sources identified in the TMDL, setting aside any control strategies for wildlife. During the first implementation phase all controllable sources would be reduced to the maximum extent practicable using the staged approach outlined above. Following completion of the first phase, DEQ would re-assess water quality in the stream to determine if the water quality standard is attained. This effort will also evaluate if the technical assumptions were correct. If water quality standards are not being met, a UAA may be initiated to reflect the presence of naturally high bacteria levels due to uncontrollable sources. In some cases, the effort may never have to go to the second phase because the water quality standard excedances attributed to wildlife may be very small and fall within the margin of error.

If water quality standards are not being met, a special study called a Use Attainability Analysis (UAA) may be initiated to reflect the presence of naturally high bacteria levels due to uncontrollable sources. The outcomes of the UAA may lead to the determination that the designated use(s) of the waters may need to be changed to reflect the attainable use(s). To remove/change a designated use, the state must demonstrate 1) that the use is not an existing use, 2) that downstream uses are protected, and 3) that the source of bacterial contamination is natural and uncontrollable by effluent limitations and by implementing cost-effective and reasonable best management practices for non-point source control (9 VAC 25-260-10). All site-specific criteria or designated use changes must be adopted as amendments to the water quality standards regulations. Watershed stakeholders and EPA will be able to provide comment during this process. Additional information can be obtained at http://www.deq.virginia.gov/wqs/WQS03AUG.pdf

7.0. Public Participation

During development of the TMDL for the Craddock Creek watershed, public involvement was encouraged through a public participation process that included public meetings and stakeholder meetings.

The first public meeting was held on March 3rd of 2005. A basic description of the TMDL process and the agencies involved was presented and a discussion was held to regarding the source assessment input, bacterial source tracking, and model results. This meeting was followed by development of the final draft TMDL and a review by the stakeholders. These comments were discussed at a technical advisory committee meeting comprised of stake holders on ___________, 2005.

The final model simulations and the TMDL load allocations were presented during the second public meeting held on____________. Public understanding of and involvement in the TMDL process was encouraged. Input from these meetings was utilized in the development of the TMDL and improved confidence in the allocation scenarios and TMDL process.

8.0 Glossary

303(d). A section of the Clean Water Act of 1972 requiring states to identify and list water bodies that do not meet the states' water quality standards.
Allocations. That portion of receiving water's loading capacity attributed to one of its existing or future pollution sources (nonpoint or point) or to natural background sources. (A wasteload allocation [WLA] is that portion of the loading capacity allocated to an existing or future point source, and a load allocation [LA] is that portion allocated to an existing or future nonpoint source or to natural background levels. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.)
Ambient water quality. Natural concentration of water quality constituents prior to mixing of either point or nonpoint source load of contaminants. Reference ambient concentration is used to indicate the concentration of a chemical that will not cause adverse impact on human health.
Anthropogenic. Pertains to the [environmental] influence of human activities.
Bacteria. Single-celled microorganisms. Bacteria of the coliform group are considered the primary indicators of fecal contamination and are often used to assess water quality.
Bacterial source tracking (BST). A collection of scientific methods used to track sources of fecal contamination.
Best management practices (BMPs). Methods, measures, or practices determined to be reasonable and cost-effective means for a landowner to meet certain, generally nonpoint source, pollution control needs. BMPs include structural and nonstructural controls and operation and maintenance procedures.
Clean Water Act (CWA). The Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972), Public Law 92-500, as amended by Public Law 96-483 and Public Law 97-117, 33 U.S.C. 1251 et seq. The Clean Water Act (CWA) contains a number of provisions to restore and maintain the quality of the nation's water resources. One of these provisions is section 303(d), which establishes the TMDL program.
Concentration. Amount of a substance or material in a given unit volume of solution; usually measured in milligrams per liter (mg/L) or parts per million (ppm).
Contamination. The act of polluting or making impure; any indication of chemical, sediment, or biological impurities.
Cost-share program. A program that allocates project funds to pay a percentage of the cost of constructing or implementing a best management practice. The remainder of the costs is paid by the producer(s).
Critical condition. The critical condition can be thought of as the "worst case" scenario of environmental conditions in the waterbody in which the loading expressed in the TMDL for the pollutant of concern will continue to meet water quality standards. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence.
Designated uses. Those uses specified in water quality standards for each waterbody or segment whether or not they are being attained.
Domestic wastewater. Also called sanitary wastewater, consists of wastewater discharged from residences and from commercial, institutional, and similar facilities.
Drainage basin. A part of a land area enclosed by a topographic divide from which direct surface runoff from precipitation normally drains by gravity into a receiving water. Also referred to as a watershed, river basin, or hydrologic unit.

Existing use. Use actually attained in the waterbody on or after November 28, 1975, whether or not it is included in the water quality standards (40 CFR 131.3).
Fecal Coliform. Indicator organisms (organisms indicating presence of pathogens) associated with the digestive tract.
Geometric mean. A measure of the central tendency of a data set that minimizes the effects of extreme values.
GIS. Geographic Information System. A system of hardware, software, data, people, organizations and institutional arrangements for collecting, storing, analyzing and disseminating information about areas of the earth. (Dueker and Kjerne, 1989)
Infiltration capacity. The capacity of a soil to allow water to infiltrate into or through it during a storm.
Interflow. Runoff that travels just below the surface of the soil.
Loading, Load, Loading rate. The total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in weight per unit time.
Load allocation (LA). The portion of a receiving waters loading capacity attributed either to one of its existing or future nonpoint sources of pollution or to natural background sources. Load allocations are best estimates of the loading, which can range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Wherever possible, natural and nonpoint source loads should be distinguished (40 CFR 130.2(g)).
Loading capacity (LC). The greatest amount of loading a water body can receive without violating water quality standards.
Margin of safety (MOS). A required component of the TMDL that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water body (CWA section 303(d)(1)©). The MOS is normally incorporated into the conservative assumptions used to develop TMDLs (generally within the calculations or models) and approved by EPA either individually or in state/EPA agreements. If the MOS needs to be larger than that which is allowed through the conservative assumptions, additional MOS can be added as a separate component of the TMDL (in this case, quantitatively, a TMDL = LC = WLA + LA + MOS).
Mean. The sum of the values in a data set divided by the number of values in the data set.
Monitoring. Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.
Narrative criteria. Non-quantitative guidelines that describe the desired water quality goals.
Nonpoint source. Pollution that originates from multiple sources over a relatively large area. Nonpoint sources can be divided into source activities related to either land or water use including failing septic tanks, improper animal-keeping practices, forest practices, and urban and rural runoff.
Numeric targets. A measurable value determined for the pollutant of concern, which, if achieved, is expected to result in the attainment of water quality standards in the listed waterbody.
Point source. Pollutant loads discharged at a specific location from pipes, outfalls, and conveyance channels from either municipal wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving water waterbody or river.
Pollutant. Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water. (CWA section 502(6)).

Pollution. Generally, the presence of matter or energy whose nature, location, or quantity produces undesired environmental effects. Under the Clean Water Act, for example, the term is defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water.

Privately owned treatment works. Any device or system that is (a) used to treat wastes from any facility whose operator is not the operator of the treatment works and (b) not a publicly owned treatment works.

Public comment period. The time allowed for the public to express its views and concerns regarding action by EPA or states (e.g., a Federal Register notice of a proposed rule-making, a public notice of a draft permit, or a Notice of Intent to Deny).

Publicly owned treatment works (POTW). Any device or system used in the treatment (including recycling and reclamation) of municipal sewage or industrial wastes of a liquid nature that is owned by a state or municipality. This definition includes sewers, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

Raw sewage. Untreated municipal sewage.

Receiving waters. Creeks, streams, rivers, lakes, estuaries, ground-water formations, or other bodies of water into which surface water and/or treated or untreated waste are discharged, either naturally or in man-made systems.

Riparian areas. Areas bordering streams, lakes, rivers, and other watercourses. These areas have high water tables and support plants that require saturated soils during all or part of the year. Riparian areas include both wetland and upland zones.

Riparian zone. The border or banks of a stream. Although this term is sometimes used interchangeably with floodplain, the riparian zone is generally regarded as relatively narrow compared to a floodplain. The duration of flooding is generally much shorter, and the timing less predictable, in a riparian zone than in a river floodplain.

Runoff. That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into receiving waters.

Septic system. An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of a tank that receives waste from a residence or business and a drain field or subsurface absorption system consisting of a series of percolation lines for the disposal of the liquid effluent. Solids (sludge) that remain after decomposition by bacteria in the tank must be pumped out periodically.

Sewer. A channel or conduit that carries wastewater and storm water runoff from the source to a treatment plant or receiving stream. Sanitary sewers carry household, industrial, and commercial waste. Storm sewers carry runoff from rain or snow. Combined sewers handle both.

Slope. The degree of inclination to the horizontal. Usually expressed as a ratio, such as 1:25 or 1 on 25, indicating one unit vertical rise in 25 units of horizontal distance, or in a decimal fraction (0.04), degrees (2 degrees 18 minutes), or percent (4 percent).

Stakeholder. Any person with a vested interest in the TMDL development.

Surface area. The area of the surface of a waterbody; best measured by planimetry or the use of a geographic information system.

Surface runoff. Precipitation, snowmelt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants.

Surface water. All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors directly influenced by surface water.

Topography. The physical features of a geographic surface area including relative elevations and the positions of natural and man-made features.

Total Maximum Daily Load (TMDL). The sum of the individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources and natural background, plus a margin of safety (MOS). TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standard.

VADEQ. Virginia Department of Environmental Quality.

VDH. Virginia Department of Health.

Virginia Pollutant Discharge Elimination System (NPDES). The national program for issuing, modifying, revoking and re-issuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under sections 307, 402, 318, and 405 of the Clean Water Act.

Wasteload allocation (WLA). The portion of a receiving waters' loading capacity that is allocated to one of its existing or future point sources of pollution. WLAs constitute a type of water quality-based effluent limitation (40 CFR 130.2(h)).

Wastewater. Usually refers to effluent from a sewage treatment plant. See also **Domestic wastewater**.

Wastewater treatment. Chemical, biological, and mechanical procedures applied to an industrial or municipal discharge or to any other sources of contaminated water to remove, reduce, or neutralize contaminants.

Water quality. The biological, chemical, and physical conditions of a waterbody. It is a measure of a waterbody's ability to support beneficial uses.

Water quality criteria. Levels of water quality expected to render a body of water suitable for its designated use, composed of numeric and narrative criteria. Numeric criteria are scientifically derived ambient concentrations developed by EPA or states for various pollutants of concern to protect human health and aquatic life. Narrative criteria are statements that describe the desired water quality goal. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.

Water quality standard. Law or regulation that consists of the beneficial designated use or uses of a waterbody, the numeric and narrative water quality criteria that are necessary to protect the use or uses of that particular waterbody, and an antidegradation statement.

Watershed. A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

WQIA. Water Quality Improvement Act.

9.0 Citations

Kuo, A., Butt, A., Kim, S. and J. Ling (1998). Application of a tidal prism water quality model to Virginia Small Coastal Basins. SRAMSOE No. 348.

Shen, J., H. Wang, and M. Sisson (2002). Application of an Integrated Watershed and Tidal prism Model to the Poquoson Coastal Embayment. Contract report submitted to the Virginia Department of Environmental Quality. Virginia Institute of Marine Science Special Report 380, Gloucester Point, VA.

Thomann, R. V. and J. Mueller (1987). Principles of surface water quality modeling and control. Harper Collins Publishers.

US EPA Shellfish Workshop Document (2002).

VA DEQ 1998 303(d) List of Impaired Waters.

10.0 Appendices

Appendix A Growing Area 28: Shoreline Sanitary Survey and Condemnation Notices

Appendix B Supporting Documentation and Watershed Assessment

Appendix C Water Quality Data

Appendix D 1) Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.
2) 33 CFR Volume 2, Parts 120 to 199. Revised as of July 1, 2000

Appendix F Public Comments

83

CRADDOCK CREEK

Accomack County

Shoreline Sanitary Survey

Date: November 16, 1994

Survey Period: August 19, 1994 - October 3, 1994

Total Number of Properties Surveyed: 52

Surveyed by: R. S. Bisker

SECTION A: GENERAL

This survey area extends from Reference Point 83 at Milbys Point to Reference Point 84 at Powells Bluff, including the Chesapeake Bay shoreline between these points, Back Creek, Craddock Creek, Bull Cove, and all of their tributaries. The survey boundary was revised and all properties east of Rt. 615 in Craddockville to the old survey boundary and all properties south of Rt. 613 to Rt. 612 were eliminated.

The terrain is relatively low, varying from low marsh along the bay to a 30′ elevation in the extreme eastern headwaters. The area is sparsely populated. The economy is based on farming of small grains, soybeans and truck crops.

Meteorological data indicated that .42" rain fell August 19-31, 3.61" in September and 0" October 1-3, for a total rainfall of 4.03" during the survey period.

All properties throughout the survey area are served by individual on-site sewage disposal systems.

The current restriction on shellfish harvesting is Condemned Shellfish Area # 195, Craddock Creek, condemned September 13, 1994.

Information in this report is gathered by and primarily for use of the Division of Shellfish Sanitation, Virginia Department of Health, in order to fulfill its responsibilities of shellfish growing area supervision and classification. However, the data are made available to various agencies participating in shellfish program coordinated activities or other interested parties. The Engineering Appendix is available by request from the Richmond Office of the Division of Shellfish Sanitation.

SECTION B: SEWAGE POLLUTION SOURCES

SEWAGE TREATMENT FACILITIES, DIRECT

-None-

SEWAGE TREATMENT FACILITIES, INDIRECT

-None-

ON-SITE SEWAGE DEFICIENCIES, DIRECT

-None-

ON-SITE SEWAGE DEFICIENCIES, INDIRECT

2. CONTRIBUTES POLLUTION - Owner: [redacted] RFD Box 50, Belle Haven 23306. Occupant: [redacted] 11441 Indian Trail Road, Craddockville 23341. Dwelling- white vinyl siding 1 story. 2 persons. Effluent erupting from drain field onto ground surface 1000′ from head of Craddock Creek at 15′ elevation. Sanitary Notice issued 8-25-94 to field #B-45.

POTENTIAL POLLUTION

-None-

SECTION D: CONTRIBUTES BOAT POLLUTION

MARINAS

-None-

OTHER PLACES WHERE BOATS ARE MOORED

-None-

UNDER SURVEILLANCE

-None-

SECTION E: ANIMAL POLLUTION SOURCES

CONTRIBUTES ANIMAL POLLUTION, DIRECT

-None-

CONTRIBUTES ANIMAL POLLUTION, INDIRECT

-None-

SUMMARY

SECTION B: SEWAGE POLLUTION SOURCES

1. **SEWAGE TREATMENT FACILITIES**

   0 - DIRECT - None
   0 - INDIRECT - None

   0 - Total

2. **ON-SITE SEWAGE DEFICIENCIES** - Correction of deficiencies in this section is the responsibility of the local health dept.

   0 - CONTRIBUTES POLLUTION, DIRECT - None
   1 - CONTRIBUTES POLLUTION, INDIRECT - #2
   0 - CP (Kitchen or Laundry Wastes), DIRECT - None
   0 - CP (Kitchen or Laundry Wastes), INDIRECT - None
   0 - NO FACILITIES, DIRECT - None
   0 - NO FACILITIES, INDIRECT - None

   1 - Total

3. **POTENTIAL POLLUTION** - Periodic surveillance of these properties will be maintained to determine any status change.

   0 - POTENTIAL POLLUTION - None

   0 - Total

SECTION C: NONSEWAGE WASTE SITES

1. **INDUSTRIAL WASTES**

   0 - DIRECT - None
   0 - INDIRECT - None

   0 - Total

2. **SOLID WASTE DUMPSITES**

   0 - DIRECT - None
   1 - INDIRECT - #1

   1 - Total

SECTION D: CONTRIBUTES BOAT POLLUTION

0 - MARINAS - None
0 - OTHER PLACES WHERE BOATS ARE MOORED - None
0 - UNDER SURVEILLANCE - None

0 - Total

SECTION E: CONTRIBUTES ANIMAL POLLUTION

0 - DIRECT - None
0 - INDIRECT - None

0 - Total

Appendix A: Growing Area 27 1) Shoreline Sanitary Survey 2004

COMMONWEALTH of VIRGINIA

Department of Health
DIVISION OF SHELLFISH SANITATION
109 Govenor Street, Room 614-B
Richmond, VA 23219

Ph: 804-864-7487
Fax: 804-864-7481

CRADDOCK CREEK
Growing Area #83
Accomack County
Shoreline Sanitary Survey

Date: April 20, 2004
Survey Period: February 13, 2004 – March 31, 2004
Total Number of Properties Surveyed: 65
Surveyed By: J. W. Hume

SECTION A - GENERAL

This survey area extends from Reference point 83 at Milbys Point to Reference Point 84 at Powells Bluff, including the Chesapeake Bay shoreline between these points, Back Creek, Craddock Creek, Bull Cove, and all of their tributaries. The survey boundary was revised in 1994 and all properties east of RT. 615 in Craddockville to the old survey boundary and all properties south of RT.613 to Rt. 612 were eliminated.

The terrain is relatively low, varying from low marsh along the bay to a 30' elevation in the extreme eastern headwaters. The area is sparsely populated. The economy is based on farming of small grains, soybeans, and truck crops.

Meteorological data indicated that .55" rain fell February 13-29 and 1.88" in March, for a total rainfall of 2.64" during the survey period.

All properties throughout the survey area are served by individual on-site sewage disposal systems.

The current restriction on shellfish harvesting is Condemned Shellfish Area #195, Craddock Creek, condemned September 13, 1994, revised August 28, 1996, revise August 28, 1997.

Information in this report is gathered by and primarily for use of the Division of Shellfish Sanitation, Virginia Department of Health, in order to fulfill its responsibilities of shellfish growing area supervision and classification. However, the data are made available to various agencies participating in shellfish program coordinated activities or other interested parties. The Engineering Appendix is available by request from the Richmond Office of the Division of Shellfish Sanitation.

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment
www.vdh.virginia.gov/shellfish

Report copies are provided to the local health department for corrective action of deficiencies listed on the summary page in Sections B. 2. and B. 3. and the Department of Environmental Quality for possible action at properties listed on the summary page in Sections B. 1., C. 1. and C. 2. The Division of Soil and Water Conservation is provided information on possible sources of animal pollution found in Section E.

This report lists only those properties which have a sanitary deficiency or have other environmental significance. **"Direct"** indicates that the significant activity or deficiency has a direct impact on shellfish waters. Individual field forms with full information on properties listed in this report are on file in the Richmond Office of the Division of Shellfish Sanitation and are available for reference until superseded by a subsequent resurvey of the area.

SECTION B: SEWAGE POLLUTION SOURCES

SEWAGE TREATMENT FACILITIES

-None-

ON-SITE SEWAGE DEFICIENCIES

-None-

POTENTIAL POLLUTION

-None-

SECTION C: NONSEWAGE WASTE SITES

INDUSTRIAL WASTES

-None-

SOLID WASTE DUMPSITES

2. Accomack County, Accomac 23301. Public- trash dumpster. No contact. Dumpster site in acceptable condition at time of inspection. Trash is emptied from dumpsters weekly.

SECTION D: BOATING ACTIVITY

MARINAS

-None-

OTHER PLACES WHERE BOATS ARE MOORED

-None-

UNDER SURVEILLANCE

-None-

SECTION E: CONTRIBUTES ANIMAL POLLUTION

1. Owner: Dr. W.H. Turner, 34168 Hyslop Lane, Craddockville 23341. Location: end of Rt. 752. Gray frame pen. Present at time of survey were approximately 25 assorted fowl contained in a pen approximately 75' from a tributary of Craddock Creek.

SUMMARY

Area # 83
Craddock Creek
April 20, 2004

SECTION B: SEWAGE POLLUTION SOURCES

1. SEWAGE TREATMENT FACILITIES

0 - DIRECT
0 - INDIRECT
0 - TOTAL

2. ON-SITE SEWAGE DEFICIENCIES - Correction of deficiencies in this section is the responsibility of the local health department.

0 - CONTRIBUTES POLLUTION, DIRECT
0 - CONTRIBUTES POLLUTION, INDIRECT
0 - CP (Kitchen or Laundry Wastes), DIRECT
0 - CP (Kitchen or Laundry Wastes), INDIRECT
0 - NO FACILITIES, DIRECT
0 - NO FACILITIES, INDIRECT
0 - TOTAL

3. POTENTIAL POLLUTION -

Periodic surveillance of these properties will be maintained to determine any status change.

0 - POTENTIAL POLLUTION

SECTION C: NON-SEWAGE WASTE SITES

1. INDUSTRIAL WASTE SITES

0 - DIRECT
0 - INDIRECT
0 - TOTAL

2. SOLID WASTE DUMPSITES

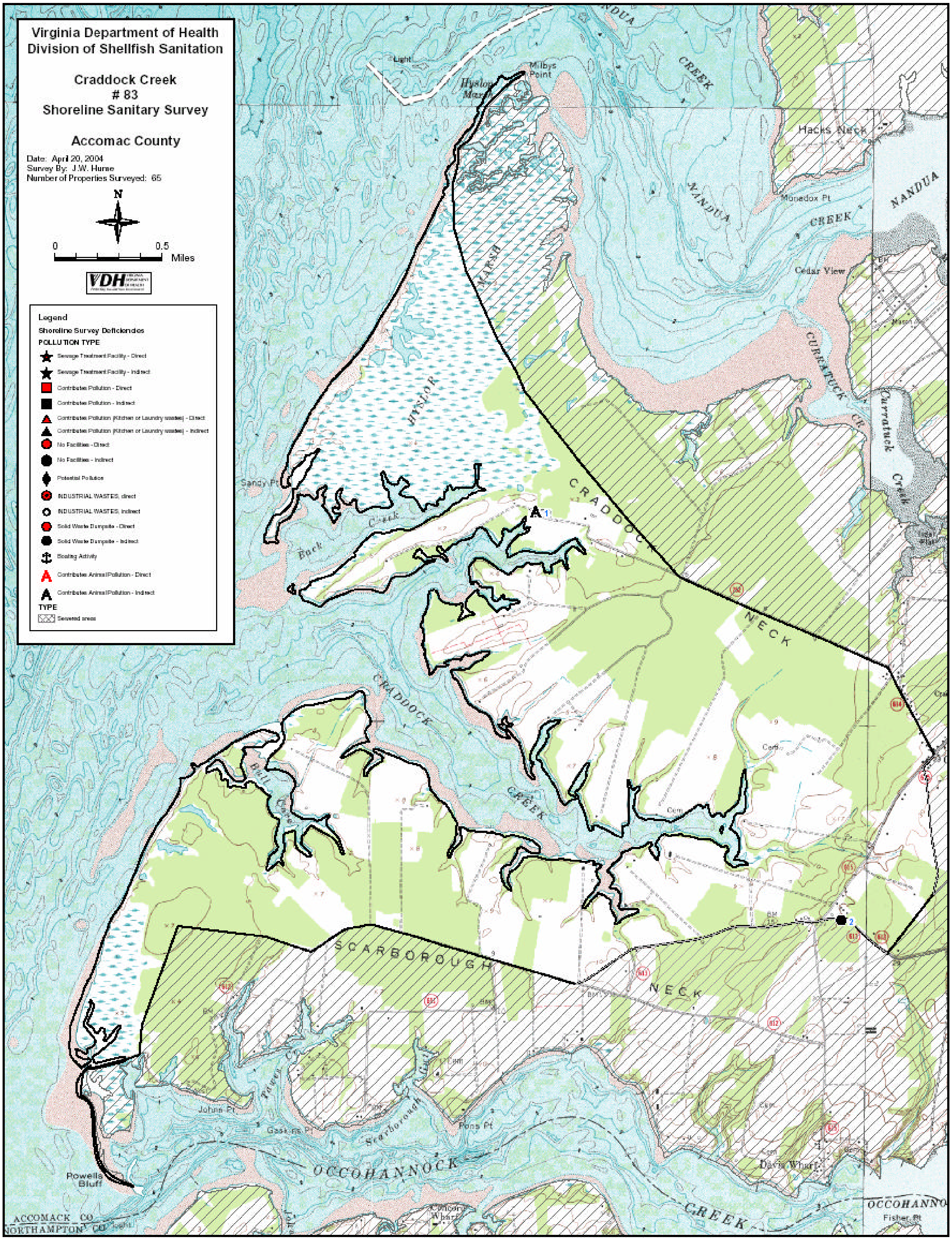
0 - DIRECT
1 - INDIRECT - #2
1 - TOTAL

SECTION D: BOATING ACTIVITY

0 - MARINAS
0 - OTHER PLACES WHERE BOATS ARE MOORED
0 - UNDER SURVEILLANCE
0 - TOTAL

SECTION E: CONTRIBUTES ANIMAL POLLUTION

0 - DIRECT
1 - INDIRECT - #1
1 - TOTAL



Virginia Department of Health
Division of Shellfish Sanitation
Craddock Creek
83
Shoreline Sanitary Survey
Accomac County
Date: April 20, 2004
Survey By: J.W. Hume
Number of Properties Surveyed: 65
N
0
0.5
Miles
VDH
Legend
Shoreline Survey Deficiencies
POLLUTION TYPE
Sewage Treatment Facility - Direct
Sewage Treatment Facility - Indirect
Contributes Pollution - Direct
Contributes Pollution - Indirect
Contributes Pollution (Kitchen or Laundry wastes) - Direct
Contributes Pollution (Kitchen or Laundry wastes) - Indirect
No Facilities - Direct
No Facilities - Indirect
Potential Pollution
INDUSTRIAL WASTES, direct
INDUSTRIAL WASTES, indirect
Solid Waste Dumpsite - Direct
Solid Waste Dumpsite - Indirect
Boating Activity
Contributes Animal Pollution - Direct
Contributes Animal Pollution - Indirect
TYPE
Sewered areas
Milbys Point
Hacks Neck
Monedox Pt
NANDUA
CREEK
Cedar View
CURRATUCK
HYSLOP
MARSH
Sandy Pt
Back
Creek
CRADDOCK
NECK
CREEK
SCARBOROUGH
NECK
Johns Pt
Gaskins Pt
Pons Pt
OCCOHANNOCK
CREEK
Davis Wharf
Powells Bluff
ACCOMACK CO
NORTHAMPTON CO
OCCOHANNO
Fisher Pt

2) Condemnation Notice(s): **Condemnation Notice 195: Craddock Creek**

REGISTRAR OF REGULATIONS
97 AUG 15 AM 9: 35

COMMONWEALTH *of* VIRGINIA

RANDOLPH L. GORDON, M.D., M.P.H.
COMMISSIONER

Department of Health
Office of Water Programs
Division of Shellfish Sanitation
1500 East Main Street, Suite 109
Richmond, Virginia 23219-3635

PHONE (804) 786-7937
FAX (804) 786-5567

NOTICE AND DESCRIPTION OF SHELLFISH AREA CONDEMNATION NUMBER 195, CRADDOCK CREEK

EFFECTIVE 28 AUGUST 1997

Pursuant to Title 28.2, Chapter 8, §§28.2-803 through 28.2-808, §32.1-20, and §9-6.14:4.1, B.16 of the *Code of Virginia:*

1. The "Notice and Description of Shellfish Area Condemnation Number 195, Craddock Creek," effective 28 August 1996, is cancelled effective 28 August 1997.

2. Condemned Shellfish Area Number 195, Craddock Creek, is established, effective 28 August 1997. It shall be unlawful for any person, firm, or corporation to take shellfish from area #195 for any purpose, except by permit granted by the Marine Resources Commission, as provided in Section 28.2-810 of the *Code of Virginia.* The boundaries of the area are shown on map titled "Craddock Creek, Condemned Shellfish Area Number 195, 28 August 1997" which is a part of this notice.

3. The Department of Health will receive, consider and respond to petitions by any interested person at any time with respect to reconsideration or revision of this order.

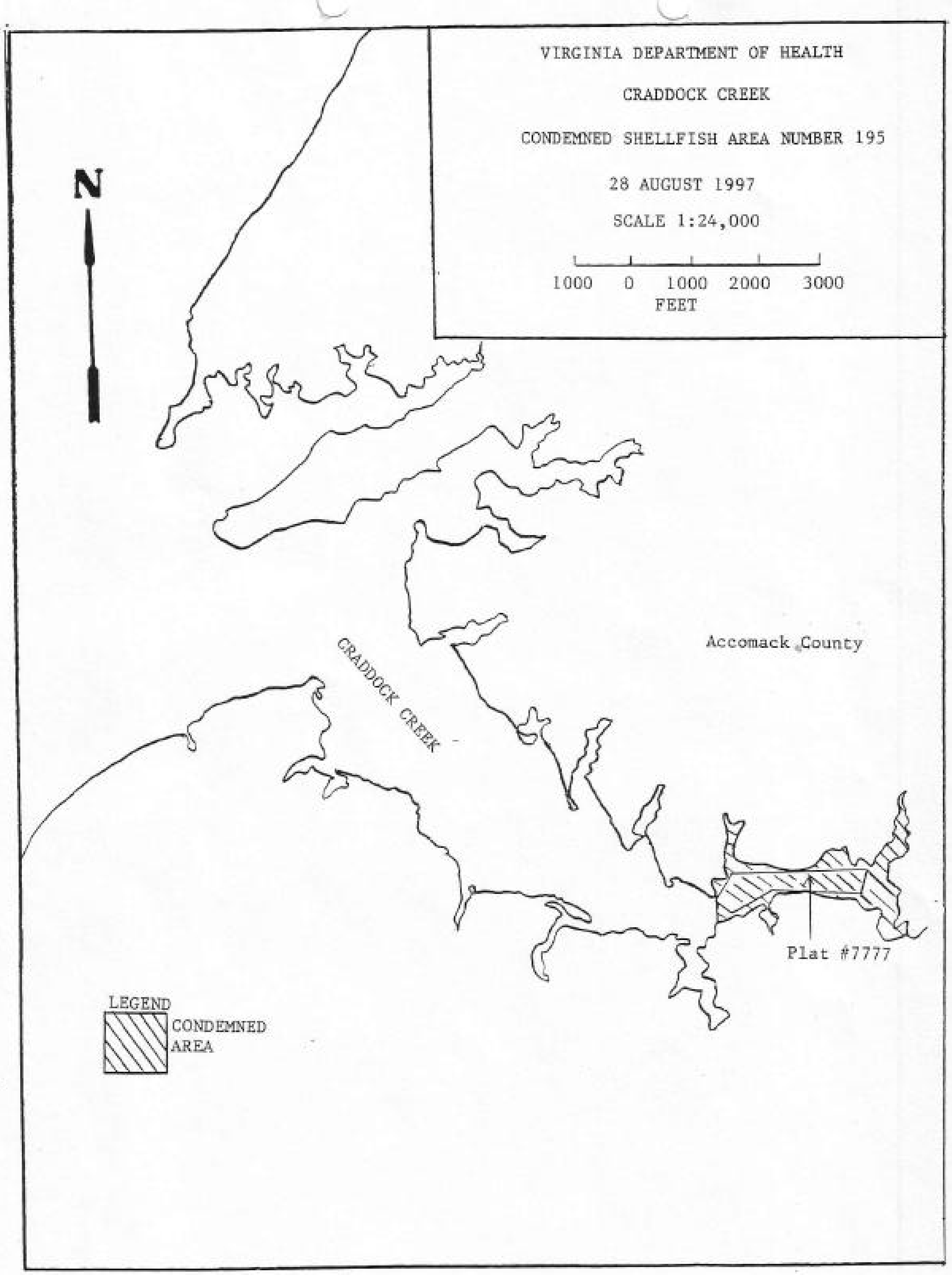
BOUNDARIES OF CONDEMNED AREA NUMBER 195

The condemned area shall include all of Craddock Creek and its tributaries lying upstream of a line drawn due north-south from the westernmost point of plat #7777.

Recommended by: MWright
for Director, Division of Shellfish Sanitation

Ordered by: Carl W. Armstrong 8/13/97
State Health Commissioner Date
SIGNED PURSUANT TO AUTHORITY VESTED IN DEPUTY HEALTH COMMISSIONER BY S32.1-22; Code of VA

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment


VIRGINIA DEPARTMENT OF HEALTH
CRADDOCK CREEK
CONDEMNED SHELLFISH AREA NUMBER 195
28 AUGUST 1997
SCALE 1:24,000
1000 0 1000 2000 3000
FEET
N
CRADDOCK CREEK
Accomack County
Plat #7777
LEGEND
CONDEMNED AREA

Appendix B: Supporting Documentation and Watershed Assessment

1. **Fecal Production Literature Review**
2. **Steady State Tidal Prism Model**
3. **Geographic Information System Data: Sources and Process**
4. **Watershed Source Assessment**

1. Fecal Production Literature Review

	Concentration in feces		Fecal coliform production rate		Comments
	FC/g	Ref.	FC/day (seasonal)	Ref.	
Cat	7.9E+06	1	5.0E+09	4	
Dog	2.3E+07	1	5.0E+09	4	
Chicken	1.3E+06	1	1.9E+08	4	
Chicken			2.4E+08	9	
Cow	2.3E+05	1	1.1E+11	4	average of dairy and beef
Beef cattle			5.4E+09	9	
Deer	1.0E+02	6	2.5E+04	6	assume 250 g/day
Deer	?		5.0E+08	9	best prof. judgement
Duck			4.5E+09	4	average of 3 sources
Duck	3.3E+07	1	1.1E+10	9	
Canada Geese			4.9E+10	4	
Canada Geese	3.6E+04	3	9.0E+06	3	
Canada Geese	1.5E+04	8	3.8E+06	8	assume 250 g/day (3)
Horse			4.2E+08	4	
Pig	3.3E+06	1	5.5E+09	4	
Pig			8.9E+09	9	
Sea Gull	3.7E+08	8	3.7E+09	8	assume 10 g/day
Sea gull			1.9E+09	5	mean of four species
Rabbit	2.0E+01	2	?		
Raccoon	1.0E+09	6	1.0E+11	6	assume 100 g/day
Sheep	1.6E+07	1	1.5E+10	4	
Sheep			1.8E+10	9	
Turkey	2.9E+05	1	1.1E+08	4	
Turkey			1.3E+08	9	
Rodent	1.6E+05	1	?		
Muskrat	3.4E+05	6	3.4E+07	6	
Human	1.3E+07	1	2.0E+09	4	
Septage	4.0E+05	7	1.0E+09	7	assume 70/gal/day/person

1. Geldreich, E. and E. A. Kenner. 1969. Concepts of fecal streptococci in stream pollution. J. Wat. Pollut. Control Fed. 41:R336-R352.
2. Geldreich, E., E. C. Best, B. A. Kenner, and D. J. Van Donsel. 1968. The bacteriological aspects of stormwater pollution. J. Wat. Pollut. Control Fed. 40:1861-1872.
3. Hussong, D., J. M. Damare, R. J. Limpert, W. J. L. Sladen, R. M. Weiner, and R. R. Colwell. 1979. Microbial impact of Canada geese (Branta canadensis) and whistling swans.
4. U.S. Environmental Protection Agency. 2001. Protocol for Developing Pathogen TMDLs. EPA 841-R-00-002. Office of Water (4503F), United States Environmental Protection Agency, Washington, DC. 132 pp.
5. Gould, D. J. and M. R. Fletcher. 1978. Gull droppings and their effects on water quality. Wat. Res. 12:665-672.
6. Kator, H. and M. W. Rhodes. 1996. Identification of pollutant sources contributing to degraded sanitary water quality in Taskinas Creek National Estuarine Research Reserve, Virginia. Special Report in Applied Marine Science and Ocean Engineering No. 336, The College of William and Mary, VIMS/School of Marine Science.
7. Kator, H., and M. W. Rhodes. 1991. Evaluation of Bacteroides fragilis bacteriophage, a candidate human-specific indicator of fecal contamination for shellfish-growing waters. A final report prepared under NOAA Cooperative Agreement NA90AA-H-FD234. Prepared and submitted to NOAA, Southeast Fisheries Science Center, Charleston Laboratory, Charleston, SC. 98 pp.
8. Alderisio, K. A. and N. DeLuca. 1999. Seasonal enumeration of fecal coliform bacteria from the feces of ring-billed gulls (Larus delawarensis) and Canada geese (Branta canadensis). Appl. Environ. Microbiol. 65:5628-5630.
9. TMDL report attributed to Metcalf and Eddy 1991 (Potomac Headwaters of West VA).

2. Steady State Tidal Prism Model

A detailed description of the tidal prism model is presented in this section. It is assumed that a single volume can represent a water body, and that the pollutant is well mixed in the water body system, as shown in Figure A-1.

The mass balance of water can be written as follows (Guo and Lordi, 2000):

$$\frac{dV}{dT} = (Q_0 - Q_b + Q_f) \tag{1}$$

where Q_0 is the quantity of water that enters the embayment on the flood tide through the ocean boundary (m^3T^{-1}); Q_b is the quantity of mixed water that leaves the bay on the ebb tide that did not enter the bay on the previous flood tide (m^3 per tidal cycle); Q_f is total freshwater input over the tidal cycle (m^3); V is the volume of the bay (m^3); T is the dominant tidal period (hours).

It is further assumed that Q_0 is the pure ocean water that did not flow out of the embayment on the previous ebb tide, and that Q_b is the embayment water that did not enter into the system on the previous flood tide. The mass balance for the fecal coliform can then be written as follows:

$$\frac{dVC}{dT} = Q_0C_0 - Q_bC + L_f + L_l - kVC \tag{2}$$

where L_f is the loading from upstream; L_l is the additional loading from the local area within the tidal cycle, k is the fecal coliform removal rate (or a damped parameter for the net loss of fecal coliform), C is fecal coliform concentration in the embayment, and C_0 is the fecal coliform concentration from outside the embayment.

In a steady-state condition, the mass balance equations for the water and the fecal coliform concentration can be written as follows:

$$Q_b = Q_0 + Q_f \tag{3}$$

$$Q_bC + kVC = Q_0C_0 + L_f + L_l \tag{4}$$

The fecal coliform concentration in the embayment can be calculated as follows:

$$C = \frac{Q_0C_0 + L_f + L_l}{Q_b + kV} \tag{5}$$

From Equation (4), assuming $L_f + L_l = Load_t$ and letting C_c be the criterion of fecal coliform in the embayment, the loading capacity can be estimated as:

$$Load_T = C_c(Q_b + kV) - Q_0 C_0 \qquad (6)$$

If we assume the concentration outside of the embayment is negligible, and there no freshwater discharge, equation 6 may be simplified as:

$$Load_r = (r+k)*C_c*V \qquad (7)$$

Where r is flushing rate.

The daily load can be estimated based on the dominant tidal period in the area. For the Chesapeake Bay the dominant tide is lunar semi-diurnal (M_2) tide with a tidal period of 12.42 hours. If fecal coliform concentration is in MPN/100ml, the daily load (counts day^{-1}) can be estimated as:

$$Load = Load_T \times \frac{24}{12.42} \times 10000 \qquad (8)$$

In practice, one may not know Q_0 *a priori*. Instead, one is given the tidal range of the tidal embayment. From that, Q_T, the total ocean water entering the bay on the flood tide, can be calculated. From this, Q_0, the volume of new ocean water entering the embayment on the flood tide can be determined by the use of the ocean tidal exchange ratio β as:

$$Q_0 = bQ_T \qquad (9)$$

where β is the exchange ratio and Q_T is the total ocean water entering the bay on the flood tide. The exchange ratio can be estimated from salinity data (Fischer et al., 1979):

$$b = \frac{S_f - S_e}{S_0 - S_e} \qquad (10)$$

where S_f is the average salinity of ocean water entering the bay on the flood tide, S_e is the average salinity of the bay water leaving the bay, and S_0 is the salinity at the ocean side. The numerical value of β is usually smaller than 1, and it represents the fraction of new ocean water entering the embayment. Once Q_0 is known, then Q_b can be calculated from equation (3).

The residence time, T_L, is an estimate of time required to replace the existing pollutant concentration in a system; it can be calculated as follows:

$$T_L = \frac{V_b}{Q_b} \qquad (11)$$

where V_b is mean volume of the embayment. From the definition, the denominator can either be Q_T or Q_b. However, using Q_T assumes that the ocean water enters into the embayment during the flood tide is 100% new, whereas using Q_b takes into consideration that a portion of water is not entirely new. It can be shown that the latter is more realistic. If Q_b is used in the residence time calculation, it will result in a longer time scale than if Q_T is used (Ketchum, 1951; Guo and Lordi, 2000).

Table B-5 lists the errors associated with estimated load corresponding to the model parameter selection. It can be seen that introducing a 20% error in model parameters results in a 0.5% to 19% error in load estimation.

Table B-1: Sensitivity of Model Parameter Selection

Units	Return Ratio	Boundary Condition MPN/100ml	Decay Rate per day	Freshwater Input cfs	Tidal Range M
Model Parameter	0.5	52.0	2	4	0.5
Change of model Parameter	0.1	10.4	0.4	4	0.1
Error introduced in model parameter	20%	20%	20%	100%	20%
Error introduced in load estimation	1.90%	2.00%	18.30%	0.52%	4.7%
Change of reduction due to change of parameters	0.81%	0.82%	0.81%	0.05%	0.06%

Fischer, H.B., List, E.J., Koh, R.C.Y., Imberger, J., and N.H. Brooks (1979): Mixing in inland and coastal water, Academic, San Diego.

Guo, Q. and G. P. Lordi (2000). “Method for quantifying freshwater input and flushing time in an estuary.” J. of Environmental Engineering, vol. 126, No. 7, ASCE, 675-683.

Ketchum, B. H. (1951). “The exchanges of fresh and salt water in tidal estuaries.” J. of Marine Research, 10(1): 18-38.

B-3 Geographic Information System Data: Sources and Process

A geographic information system is a powerful computer software package that can store large amounts of spatially referenced data and associated tabular information. The data layers produced by a GIS can be used for many different tasks, such as generating maps, analyzing results, and modeling processes. Below is a table that lists the data layers that were developed for the watershed and hydrodynamic models.

Table B-2 GIS Data Elements and Sources

Data Element	Source	Date
Watershed boundary	Division of Shellfish Sanitation, VA Department of Health	Various dates
Subwatershed boundary	Center for Coastal Resources Management	2003
Land use	National Land Cover Data set (NLCD), US Geological Survey	1999
Elevation	Digital Elevation Models and Digital Raster Graphs, US Geological Survey	Various dates
Soils	SSURGO and STATSGO, National Resource Conservation Service	Various dates
Stream network	National Hydrography Dataset	1999
Precipitation, temperature, solar radiation, and evapotranspiration	Chesapeake Bay Program, Phase V	2002
Stream flow data	Gauging stations, US Geological Survey	Various dates
Shoreline Sanitary Survey deficiencies	Division of Shellfish Sanitation, VA Department of Health	Various dates
Wastewater treatment plants	VA Department of Environmental Quality	Various dates
Sewers	Division of Shellfish Sanitation, VA Department of Health	Various dates
Dog population	US Census Bureau American Veterinary Association	2000 2002
Domestic livestock	National Agricultural Statistics Service, USDA	1997/2001
Wildlife	Virginia Department of Game and Inland Fisheries, US Fish and Wildlife Service	2004 2004
Septic tanks (from human population)	Division of Shellfish Sanitation, VA Department of Health US Census Bureau	Various dates 2000
Water quality monitoring stations	Division of Shellfish Sanitation, VA Department of Health	Various dates
Water quality segments	Center for Coastal Resources Management	2003
Tidal prism segments	Department of Physical Sciences, VIMS	2003
Water body volumes	Bathymetry from Hydrographic Surveys, National Ocean Service, NOAA	Various dates
Condemnation zones	Division of Shellfish Sanitation, VA Department of Health	Various dates
Tidal data	NOAA tide tables	2004

A. GIS Data Description and Process

Watershed boundary determined by VDH, DSS. There are 105 watersheds in Virginia.

Subwatershed boundaries were delineated based on elevation, using digital 7.5 minute USGS topographic maps. There are 1836 subwatersheds.

The original land use has 15 categories that were combined into 3 categories:
urban (high and low density residential and commercial);
undeveloped (forest and wetlands); and
agriculture (pasture and crops).

Descriptions of Shoreline Sanitary Survey deficiencies are found in each report. Contact DSS for more information. Digital data layer generated by CCRM from hardcopy reports.

Wastewater treatment plant locations were obtained from DEQ and digital data layer was generated by CCRM. Design flow, measured flow, and fecal coliform discharges were obtained from DEQ.

Sewers data layer was digitized from Shoreline Sanitary Surveys by CCRM.

Dog numbers were obtained using the American Vet Associations equation of #households * 0.58. See website for additional information—
http://www.avma.org/membshp/marketstats/formulas.asp#households1.
Database was generated by CCRM.

Domestic livestock includes cows, pigs, sheep, chickens, turkeys, and horses. Database was generated by CCRM.

Wildlife includes ducks and geese, deer, and raccoons. Animals were chosen based on availability of fecal coliform production rates and population estimates. Database was generated by CCRM.
Ducks and geese–US FWS, DGIF
Deer–DGIF
Raccoons–DGIF

Human input was based on DSS sanitary survey deficiencies and US Census Bureau population data (number of households).

Water quality monitoring data are collected, on average, once per month. Digital data layer of locations was generated by DSS. Water quality data was mathematically processed and input into a database for model use.

Water bodies were divided into segments based on the location of the monitoring stations (midway between stations). If a segment contained >1 station, the FC values were averaged. If a segment contained 0 stations, the value from the closest station(s) was assigned to it. Digital data layer of segments was generated by CCRM. FC loadings in the water were obtained by multiplying FC concentrations by segment volume.

Bathymetry data were used to generate a depth grid that was used to estimate volumes for each water quality segment and tidal prism segment.

The 1998 303d report was used to set the list of condemnation zones that require TMDLs. The digital data layer was generated by CCRM from hardcopy closure reports supplied by DSS.

B. Population Numbers

The process used to generate population numbers used for the nonpoint source contribution analysis part of the watershed model for the four source categories: human, livestock, pets and wildlife is described for each below.

Human:

The number of people contributing fecal coliform from failing septic tanks were developed in two ways and then compared to determine a final value.

1) Deficiencies (septic failures) from the DSS shoreline surveys were counted for each watershed and multiplied by 3 (average number of people per household).
2) Numbers of households in each watershed were determined from US Census Bureau data. The numbers of households were multiplied by 3 (average number of people per household) to get the total number of people and then multiplied by a septic failure rate* to get number of people contributing fecal coliform from failing septic tanks.

*The septic failure rate was estimated by dividing the number of deficiencies in the watershed by the total households in the watershed. The average septic failure rate was 12% and this was used as the default unless the DSS data indicated that septic failure was higher.

Livestock:

US Census Bureau data was used to calculate the livestock values. The numbers for each type of livestock (cattle, pigs, sheep, chickens (big and small), and horses) were reported by county. Each type of livestock was assigned to the land use(s) it lives on, or contributes to by the application of manure, as follows:

Cattle	cropland and pastureland
Pigs	cropland
Sheep	pastureland
Chickens	cropland
Horses	pastureland

GIS was used to overlay data layers for several steps:

1) The county boundaries and the land uses to get the area of each land use in each county. The number of animals was divided by the area of each land use for the county to get an animal density for each county.
2) The subwatershed boundaries and the land uses to get the area of each land use in each subwatershed.
3) The county boundaries and the subwatershed boundaries to get the area of each county in each subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was used to determine the number of animals in the subwatershed.

Using MS Access, for each type of livestock, the animal density by county was multiplied by the area of each land use by county in each subwatershed to get the number of animals in each subwatershed. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of animals in the subwatershed. The number of animals in each subwatershed was summed to get the total number of animals in each watershed.

Pets:

The dog population was calculated using a formula for estimating the number of pets using national percentages, reported by the American Veterinary Association:

dogs = # of households * 0.58.

US Census Bureau data provided the number of households by county. The number of dogs per county was divided by the area of the county to get a dog density per county. GIS was used to overlay the subwatershed boundaries with the county boundaries to get the area of each county in a subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was calculated. Using MS Access, the area of each county in the subwatershed was multiplied by the dog density per county to get the number of dogs per subwatershed. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of dogs in the subwatershed. The number of dogs in each subwatershed was summed to get the total number of dogs in each watershed.

Wildlife:

<u>Deer</u>—

The number of deer were calculated using information supplied by DGIF, consisting of an average deer index by county and the formula:

#deer/mi^2 of deer habitat = (-0.64 + (7.74 * average deer index)).

Deer habitat consists of forests, wetlands, and agricultural lands (crop and pasture). GIS was used to overlay data layers for the following steps:

1) The county boundaries and the subwatershed boundaries to get the area of each county in each subwatershed. If a subwatershed straddled more than one county, the areal proportion of each county in the subwatershed was calculated.
2) The subwatershed boundaries and the deer habitat to get the area of deer habitat in each subwatershed.

Using MS Access, number of deer in each subwatershed were calculated by multiplying the #deer/mi^2 of deer habitat times the area of deer habitat. If more than one county was present in a subwatershed, the previous step was done for each county in the subwatershed, then summed for a total number of deer in the subwatershed. The number of deer in each subwatershed was summed to get the total number of deer in each watershed.

<u>Ducks and Geese</u>—

The data for ducks and geese were divided into summer (April through September) and winter (October through March).

Summer

The summer numbers were obtained from the Breeding Bird Population Survey (US Fish and Wildlife Service) and consisted of bird densities (ducks and geese) for 3 regions: the southside of the James

River, the rest of the tidal areas, and the salt marshes in both areas. The number of ducks and geese in the salt marshes were distributed into the other 2 regions based on the areal proportion of salt marshes in them using the National Wetland Inventory data and GIS.

Winter

The winter numbers were obtained from the Mid-Winter Waterfowl Survey (US Fish and Wildlife Service) and consisted of population numbers for ducks and geese in several different areas in the tidal region of Virginia. MS Access was used to calculate the total number of ducks and geese in each area and then these numbers were grouped to match the 2 final regions (Southside and the rest of tidal Virginia) for the summer waterfowl populations. Winter populations were an order of magnitude larger than summer populations.

Data from DGIF showed the spatial distribution of ducks and geese for 1993 and 1994. Using this information and GIS a 250m buffer on each side of the shoreline was generated and contained 80% of the birds. Wider buffers did not incorporate significantly more birds, since they were located too far inland. GIS was used to overlay the buffer and the watershed boundaries to calculate the area of buffer in each watershed. To distribute this information into each subwatershed, GIS was used to calculate the length of shoreline in each subwatershed and the total length of shoreline in the watershed. Dividing the length of shoreline in each subwatershed by the total length of shoreline gives a ratio that was multiplied by the area of the watershed to get an estimate of the area of buffer in each subwatershed. MS Excel was used to multiply the area of buffer in each subwatershed times the total numbers of ducks and geese to get the numbers of ducks and geese in each subwatershed. These numbers were summed to get the total number of ducks and geese in each watershed. To get annual populations, the totals then were divided by 2, since they represent only 6 months of habitation (this reduction underestimates the total annual input from ducks and geese, but is the easiest conservative method to use since the model does not have a way to incorporate the seasonal differences).

Raccoons—

Estimates for raccoon densities were supplied by DGIF for 3 habitats—wetlands (including freshwater and saltwater, forested and herbaceous), along streams, and upland forests. GIS was used to generate a 600ft buffer around the wetlands and streams, and then to overlay this buffer layer with the subwatershed boundaries to get the area of the buffer in each subwatershed. GIS was used to overlay the forest layer with the subwatershed boundaries to get the area of forest in each subwatershed. MS Access was used to multiply the raccoon densities for each habitat times the area of each habitat in each subwatershed to get the number of raccoons in each habitat in each subwatershed. The number of raccoons in each subwatershed was summed to get the total number of raccoons in each watershed.

B-4. Watershed Source Assessment

The watershed assessment calculates fecal coliform loads by source based on geographic information system data. A geographic information system is a powerful computer software package that can store large amounts of spatially referenced data and associated tabular information. The data layers produced by a GIS can be used for many different tasks, such as generating maps, analyzing results, and modeling processes. The watershed model requires a quantitative assessment of human sewage sources (i. e., malfunctioning septic systems) and animal (livestock, pets and wildlife) fecal sources distributed within each watershed.

The fecal coliform contribution from livestock is through the manure spreading processes and direct deposition during grazing. This contribution was initially estimated based on land use data and the livestock census data. In the model, manure was applied to both cropland and pasture land depending on the grazing period. Figure B-1 shows a diagram of the procedure for estimating the total number of livestock in the watershed and fecal coliform production. A description of the process used to determine the source population values for wildlife, pets and human used in the calculation of percent loading is found in Appendix B.

FIGURE B-1 Diagram to Illustrate Procedure Used to Estimate Fecal Coliform Production from Estimated Livestock Population

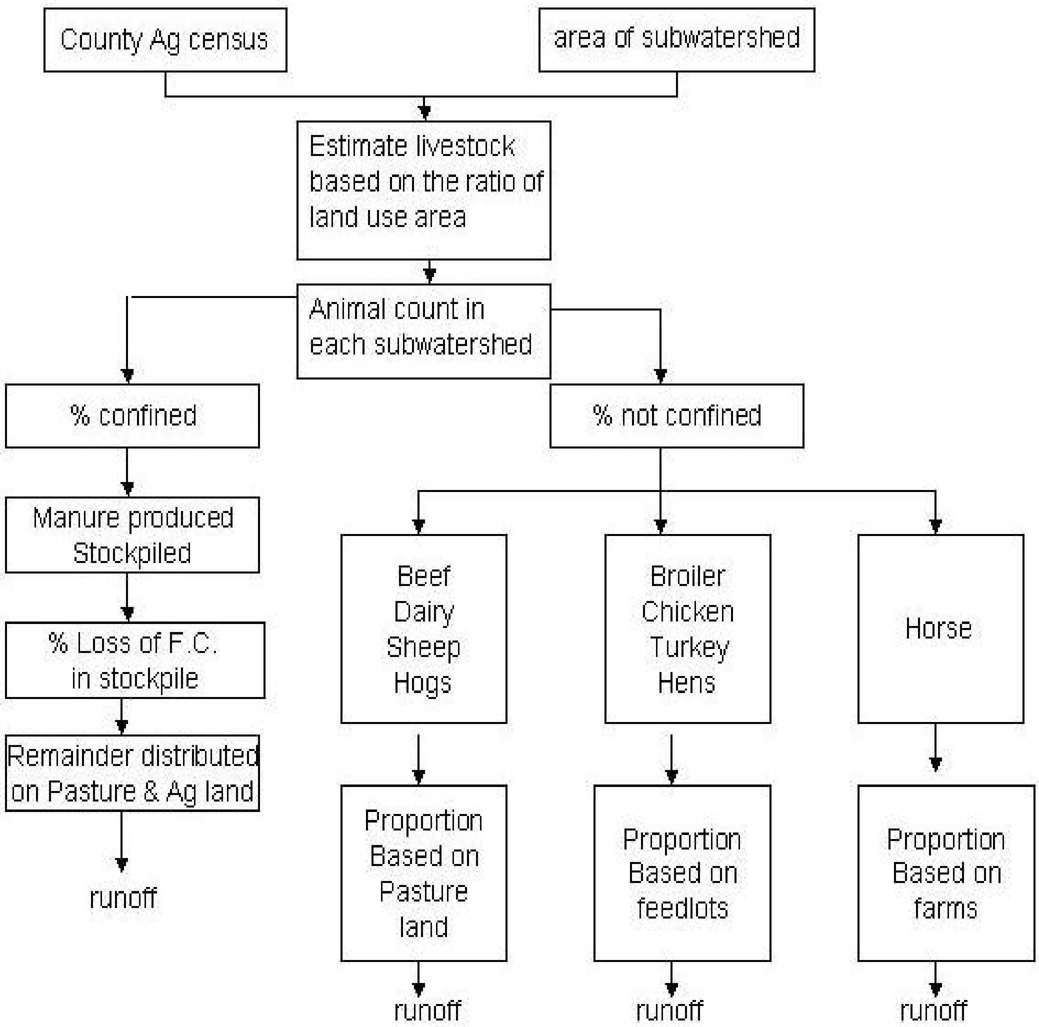


Table B-3 Nonpoint Source Load Distribution by Condemned Area Using Watershed Model: Growing Area 83

Condemned	Livestock	Wildlife	Pet	Human
195A	**3.951E+11**	**4.23E+11**	**1.693E+09**	**2.831E+10**
195B	**8.801E+11**	**4.701E+11**	**3.771E+09**	**6.306E+10**

Appendix C: Water Quality Data Summary

Table 4-3. Observed Geometric Mean and 90th Percentile By Condemned Area

Condemned Area	Mean of Geometric Means	SD Geometric Means	Mean of the 90th Means	SD 90th Means	Last 30 Sample Geo mean	Last 30 Sample 90th
195A	**6.4**	**1.6**	**29.8**	**15.5**	**7.1**	**31.9**
195B	**11.3**	**3.3**	**66.0**	**30.2**	**12.9**	**103.6**

Appendix D

1) Code of Virginia §62.1-194.1 Obstructing or contaminating state waters.
2) Code of Federal Regulations. Title 33, Volume 2, Parts 120 to 1999 Revised as of July 1, 2000

D1: Code of Virginia §62.1-194.1

§62.1-194.1. Obstructing or contaminating state waters.

Except as otherwise permitted by law, it shall be unlawful for any person to dump, place or put, or cause to be dumped, placed or put into, upon the banks of or into the channels of any state waters any object or substance, noxious or otherwise, which may reasonably be expected to endanger, obstruct, impede, contaminate or substantially impair the lawful use or enjoyment of such waters and their environs by others. Any person who violates any provision of this law shall be guilty of a misdemeanor and upon conviction be punished by a fine of not less than $100 nor more than $500 or by confinement in jail not more than twelve months or both such fine and imprisonment. Each day that any of said materials or substances so dumped, placed or put, or caused to be dumped, placed or put into, upon the banks of or into the channels of, said streams shall constitute a separate offense and be punished as such. In addition to the foregoing penalties for violation of this law, the judge of the circuit court of the county or corporation court of the city wherein any such violation occurs, whether there be a criminal conviction therefor or not shall, upon a bill in equity, filed by the attorney for the Commonwealth of such county or by any person whose property is damaged or whose property is threatened with damage from any such violation, award an injunction enjoining any violation of this law by any person found by the court in such suit to have violated this law or causing the same to be violated, when made a party defendant to such suit. (1968, c. 659.)

D2: Code of Federal Regulations. Title 33, Volume 2, Parts 120 to 1999 Revised as of July 1, 2000 From the U.S. Government Printing Office via GPO Access [CITE: 33CFR159]

NAVIGABLE WATERS

CHAPTER I--COAST GUARD, DEPARTMENT OF TRANSPORTATION (CONTINUED)

PART 159--MARINE SANITATION DEVICES

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159.119 Operability test; temperature range.
159.121 Sewage processing test.
159.123 Coliform test: Type I devices.
159.125 Visible floating solids: Type I devices.
159.126 Coliform test: Type II devices.
159.126a Suspended solids test: Type II devices.
159.127 Safety coliform count: Recirculating devices.
159.129 Safety: Ignition prevention test.
159.131 Safety: Incinerating device.

Subpart D--Recognition of Facilities

159.201 Recognition of facilities.

Authority: Sec. 312(b)(1), 86 Stat. 871 (33 U.S.C. 1322(b)(1)); 49 CFR 1.45(b) and 1.46(l) and (m).

Source: CGD 73-83, 40 FR 4624, Jan. 30, 1975, unless otherwise noted.

Subpart A--General

Sec. 159.1 Purpose.

This part prescribes regulations governing the design and construction of marine sanitation devices and procedures for certifying that marine sanitation devices meet the regulations and the standards of the Environmental Protection Agency promulgated under section 312 of the Federal Water Pollution Control Act (33 U.S.C. 1322), to eliminate the discharge of untreated sewage from vessels into the waters of the United States, including the territorial seas. Subpart A of this part contains regulations governing the manufacture and operation of vessels equipped with marine sanitation devices.

Sec. 159.3 Definitions.

In this part:
Coast Guard means the Commandant or his authorized representative.
Discharge includes, but is not limited to, any spilling, leaking, pouring, pumping, emitting, emptying, or dumping.
Existing vessel includes any vessel, the construction of which was initiated before January 30, 1975.
Fecal coliform bacteria are those organisms associated with the intestine of warm-blooded animals that are commonly used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease.
Inspected vessel means any vessel that is required to be inspected under 46 CFR Ch. I.
Length means a straight line measurement of the overall length from the foremost part of the vessel to the aftermost part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments are not to be included in the measurement.
Manufacturer means any person engaged in manufacturing, assembling, or importing of marine sanitation devices or of vessels subject to the standards and regulations promulgated under section 312 of the Federal Water Pollution Control Act.

Marine sanitation device and device includes any equipment for installation on board a vessel which is designed to receive, retain, treat, or discharge sewage, and any process to treat such sewage.
New vessel includes any vessel, the construction of which is initiated on or after January 30, 1975.
Person means an individual, partnership, firm, corporation, or association, but does not include an individual on board a public vessel.
Public vessel means a vessel owned or bare-boat chartered and operated by the United States, by a State or political subdivision thereof, or by a foreign nation, except when such vessel is engaged in commerce.
Recognized facility means any laboratory or facility listed by the Coast Guard as a recognized facility under this part.
Sewage means human body wastes and the wastes from toilets and other receptacles intended to receive or retain body waste.
Territorial seas means the belt of the seas measured from the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters, and extending seaward a distance of 3 miles.
Type I marine sanitation device means a device that, under the test conditions described in Secs. 159.123 and 159.125, produces an effluent having a fecal coliform bacteria count not greater than 1,000 per 100 milliliters and no visible floating solids.
Type II marine sanitation device means a device that, under the test conditions described in Secs. 159.126 and 159.126a, produces an effluent having a fecal coliform bacteria count not greater than 200 per 100 milliliters and suspended solids not greater than 150 milligrams per liter.
Type III marine sanitation device means a device that is designed to prevent the overboard discharge of treated or untreated sewage or any waste derived from sewage.
Uninspected vessel means any vessel that is not required to be inspected under 46 CFR Chapter I.
United States includes the States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Canal Zone, and the Trust Territory of the Pacific Islands.
Vessel includes every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on the waters of the United States.

[CGD 96-026, 61 FR 33668, June 28, 1996, as amended by CGD 95-028, 62 FR 51194, Sept. 30, 1997]

Sec. 159.4 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in paragraph (b) of this section, the Coast Guard must publish notice of change in the Federal Register; and the material must be available to the public.
All approved material is available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC, and at the U.S. Coast Guard Office of Design and Engineering Standards (G-MSE), 2100 Second Street SW., Washington, DC 20593-0001, and is available from the sources indicated in paragraph (b) of this section.
(b) The material approved for incorporation by reference in this part, and the sections affected, are as follows:

American Society for Testing and Materials (ASTM)
100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 11-95, Standard Specification for Wire Cloth and Sieves for Testing Purposes--159.125

[USCG-1999-5151, 64 FR 67176, Dec. 1, 1999]

Sec. 159.5 Requirements for vessel manufacturers.

No manufacturer may manufacture for sale, sell, offer for sale, or distribute for sale or resale any vessel equipped with installed toilet facilities unless it is equipped with:
(a) An operable Type II or III device that has a label on it under Sec. 159.16 or that is certified under Sec. 159.12 or Sec. 159.12a; or
(b) An operable Type I device that has a label on it under Sec. 159.16 or that is certified under Sec. 159.12, if the vessel is 19.7 meters (65 feet) or less in length.

[CGD 95-028, 62 FR 51194, Sept. 30, 1997]

Sec. 159.7 Requirements for vessel operators.

(a) No person may operate any vessel equipped with installed toilet facilities unless it is equipped with:
(1) An operable Type II or III device that has a label on it under Sec. 159.16 or that is certified under Sec. 159.12 or Sec. 159.12a; or
(2) An operable Type I device that has a label on it under Sec. 159.16 or that is certified under Sec. 159.12, if the vessel is 19.7 meters (65 feet) or less in length.
(b) When operating a vessel on a body of water where the discharge of treated or untreated sewage is prohibited by the Environmental Protection Agency under 40 CFR 140.3 or 140.4, the operator must secure each Type I or Type II device in a manner which prevents discharge of treated or untreated sewage. Acceptable methods of securing the device include--
(1) Closing the seacock and removing the handle;
(2) Padlocking the seacock in the closed position;
(3) Using a non-releasable wire-tie to hold the seacock in the closed position; or
(4) Locking the door to the space enclosing the toilets with a padlock or door handle key lock.
(c) When operating a vessel on a body of water where the discharge of untreated sewage is prohibited by the Environmental Protection Agency under 40 CFR 140.3, the operator must secure each Type III device in a manner which prevents discharge of sewage. Acceptable methods of securing the device include--
(1) Closing each valve leading to an overboard discharge and removing the handle;
(2) Padlocking each valve leading to an overboard discharge in the closed position; or
(3) Using a non-releasable wire-tie to hold each valve leading to an overboard discharge in the closed position.

[CGH 95-028, 62 FR 51194, Sept. 30, 1997]

Subpart B--Certification Procedures

Sec. 159.11 Purpose.

This subpart prescribes procedures for certification of marine sanitation devices and authorization for labels on certified devices.

Sec. 159.12 Regulations for certification of existing devices.

(a) The purpose of this section is to provide regulations for certification of existing devices until manufacturers can design and manufacture devices that comply with this part and recognized facilities are prepared to perform the testing required by this part.
(b) Any Type III device that was installed on an existing vessel before January 30, 1975, is considered certified.
(c) Any person may apply to the Commandant (G-MSE), U.S. Coast Guard, Washington, D.C. 20593-0001 for certification of a marine sanitation device manufactured before January 30, 1976. The Coast Guard will issue a letter certifying the device if the applicant shows that the device meets Sec. 159.53 by:
(1) Evidence that the device meets State standards at least equal to the standards in Sec. 159.53, or
(2) Test conducted under this part by a recognized laboratory, or
(3) Evidence that the device is substantially equivalent to a device certified under this section, or
(4) A Coast Guard field test if considered necessary by the Coast Guard.
(d) The Coast Guard will maintain and make available a list that identifies each device certified under this section.
(e) Devices certified under this section in compliance with Sec. 159.53 need not meet the other regulations in this part and may not be labeled under Sec. 159.16.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15325, Apr. 12, 1976; CGD 82-063a, 48 FR 4776, Feb. 3, 1983; CGD 88-052, 53 FR 25122, July 1, 1988; CGD 96-026, 61 FR 33668, June 28, 1996]

Sec. 159.12a Certification of certain Type III devices.

(a) The purpose of this section is to provide regulations for certification of certain Type III devices.
(b) Any Type III device is considered certified under this section if:
(1) It is used solely for the storage of sewage and flushwater at ambient air pressure and temperature; and
(2) It is in compliance with Sec. 159.53(c).
(c) Any device certified under this section need not comply with the other regulations in this part except as required in paragraphs (b)(2)and (d) of this section and may not be labeled under Sec. 159.16.
d) Each device certified under this section which is installed aboard an inspected vessel must comply with Sec. 159.97.

[CGD 76-145, 42 FR 11, Jan. 3, 1977]

Sec. 159.14 Application for certification.

(a) Any manufacturer may apply to any recognized facility for certification of a marine sanitation device. The application for certification must indicate whether the device will be used aboard all vessels or only aboard uninspected vessels and to which standard in Sec. 159.53 the manufacturer requests the device to be tested.
(b) An application may be in any format but must be in writing and must be signed by an authorized representative of the manufacturer and include or be accompanied by:
(1) A complete description of the manufacturer's production quality control and inspection methods, record keeping systems pertaining to the manufacture of marine sanitation devices, and testing procedures;
(2) The design for the device, including drawings, specifications and other information that describes the materials, construction and operation of the device;
(3) The installation, operation, and maintenance instructions for the device; and
(4) The name and address of the applicant and the manufacturing facility.
(c) The manufacturer must furnish the recognized facility one device of each model for which certification is requested and samples of each material from which the device is constructed, that must be tested destructively under Sec. 159.117. The device furnished is for the testing required by this part except that, for devices that are not suited for unit testing, the manufacturer may submit the design so that the recognized facility may determine the components of the device and materials to be submitted for testing and the tests to be performed at a place other than the facility. The Coast Guard must review and accept all such determinations before testing is begun.
(d) At the time of submittal of an application to a recognized facility the manufacturer must notify the Coast Guard of the type and model of the device, the name of the recognized facility to which application is being made, and the name and address of the manufacturer, and submit a signed statement of the times when the manufacturer will permit designated officers and employees of the Coast Guard to have access to the manufacturer's facilities and all records required by this part.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15325, Apr. 12, 1976]

Sec. 159.15 Certification.

(a) The recognized facility must evaluate the information that is submitted by the manufacturer in accordance with Sec. 159.14(b) (1), (2), and (3), evaluate the device for compliance with Secs. 159.53 through 159.95, test the device in accordance with Sec. 159.101 and submit to the Commandant (G-MSE), U.S. Coast Guard, Washington, D.C. 20593-0001 the following:
(1) The information that is required under Sec. 159.14(b);
(2) A report on compliance evaluation;
(3) A description of each test;
(4) Test results; and
(5) A statement, that is signed by the person in charge of testing, that the test results are accurate and complete.
(b) The Coast Guard certifies a test device, on the design of the device, if it determines, after consideration of the information that is required under paragraph (a) of this section, that the device meets the requirements in Subpart C of this part.

(c) The Coast Guard notifies the manufacturer and recognized facility of its determination under paragraph (b) of this section. If the device is certified, the Coast Guard includes a certification number for the device. If certification is denied, the Coast Guard notifies the manufacturer and recognized facility of the requirements of this part that are not met. The manufacturer may appeal a denial to the Commandant (G-MSE), U.S. Coast Guard, Washington, D.C. 20593-0001.
(d) If upon re-examination of the test device, the Coast Guard determines that the device does not in fact comply with the requirements of Subpart C of this part, it may terminate the certification.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15326, Apr. 12, 1976; CGD 82-063a, 48 FR 4776, Feb. 3, 1983; CGD 88-052, 53 FR 25122, July 1, 1988; CGD 96-026, 61 FR 33668, June 28, 1996]

Sec. 159.16 Authorization to label devices.

(a) When a test device is certified under Sec. 159.15(b), the Coast Guard will issue a letter that authorizes the manufacturer to label each device that he manufactures with the manufacturer's certification that the device is in all material respects substantially the same as a test device certified by the U.S. Coast Guard pursuant to section 312 of the Federal Water Pollution Control Act Amendments of 1972.
(b) Certification placed on a device by its manufacturer under this section is the certification required by section 312(h)(4) of the Federal Water Pollution Control Act Amendments of 1972, which makes it unlawful for a vessel that is subject to the standards and regulations promulgated under the Act to operate on the navigable waters of the United States, if such vessel is not equipped with an operable marine sanitation device certified pursuant to section 312 of the Act.
(c) Letters of authorization issued under this section are valid for 5 years, unless sooner suspended, withdrawn, or terminated and may be reissued upon written request of the manufacturer to whom the letter was issued.
(d) The Coast Guard, in accordance with the procedure in 46 CFR 2.75, may suspend, withdraw, or terminate any letter of authorization issued under this section if the Coast Guard finds that the manufacturer is engaged in the manufacture of devices labeled under this part that are not in all material respects substantially the same as a test device certified pursuant to this part.

Sec. 159.17 Changes to certified devices.

(a) The manufacturer of a device that is certified under this part shall notify the Commandant (G-MSE), U.S. Coast Guard, Washington, D.C. 20593-0001 in writing of any change in the design of the device.
(b) A manufacturer shall include with a notice under paragraph (a) of this section a description of the change, its advantages, and the recommendation of the recognized facility as to whether the device remains in all material respects substantially the same as the original test device.
(c) After notice under paragraph (a) of this section, the Coast Guard notifies the manufacturer and the recognized facility in writing of any tests that must be made for certification of the device or for any change in the letter of authorization. The manufacturer may appeal this determination to the Commandant (G-MSE), U.S. Coast Guard, Washington, D.C. 20593-0001.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 82-063a, 48 FR 4776, Feb. 3, 1983; CGD 88-052, 53 FR 25122, July 1, 1988; CGD 96-026, 61 FR 33668, June 28, 1996]

Sec. 159.19 Testing equivalency.

(a) If a test required by this part may not be practicable or necessary, a manufacturer may apply to the Commandant (G-MSE), U.S. Coast Guard, Washington, DC 20593-0001 for deletion or approval of an alternative test as equivalent to the test requirements in this part. The application must include the manufacturer's justification for deletion or the alternative test and any alternative test data.
(b) The Coast Guard notifies the manufacturer of its determination under paragraph (a) of this section and that determination is final.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 82-063a, 48 FR 4776, Feb. 3, 1983; CGD 88-052, 53 FR 25122, July 1, 1988; CGD 96-026, 61 FR 33668, June 28, 1996]

Subpart C--Design, Construction, and Testing

Sec. 159.51 Purpose and scope.

(a) This subpart prescribes regulations governing the design and construction of marine sanitation devices.
(b) Unless otherwise authorized by the Coast Guard each device for which certification under this part is requested must meet the requirements of this subpart.

Sec. 159.53 General requirements.

A device must:
(a) Under the test conditions described in Secs. 159.123 and 159.125, produce an effluent having a fecal coliform bacteria count not greater than 1,000 per 100 milliliters and no visible floating solids (Type I),
(b) Under the test conditions described in Secs. 159.126 and 159.126a, produce an effluent having a fecal coliform bacteria count not greater than 200 per 100 milliliters and suspended solids not greater than 150 milligrams per liter (Type II), or
(c) Be designed to prevent the overboard discharge of treated or untreated sewage or any waste derived from sewage (Type III).

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15325, Apr. 12, 1976]

Sec. 159.55 Identification.

(a) Each production device must be legibly marked in accordance with paragraph (b) of this section with the following information:
(1) The name of the manufacturer.
(2) The name and model number of the device.
(3) The month and year of completion of manufacture.
(4) Serial number.
(5) Whether the device is certified for use on an inspected or an uninspected vessel.
(6) Whether the device is Type I, II, or III.
(b) The information required by paragraph (a) of this section must appear on a nameplate attached to the device or in lettering on the device. The nameplate or lettering stamped on the device must be capable of withstanding without loss of legibility the combined effects of normal wear and tear and exposure to water, salt spray, direct sunlight, heat, cold, and any substance listed in Sec. 159.117(b) and (c). The nameplate and lettering must be designed to resist efforts to remove them from the device or efforts to alter the information stamped on the nameplate or the device without leaving some obvious evidence of the attempted removal or alteration.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15325, Apr. 12, 1976]

Sec. 159.57 Installation, operation, and maintenance instructions.

(a) The instructions supplied by the manufacturer must contain directions for each of the following:
(1) Installation of the device in a manner that will permit ready access to all parts of the device requiring routine service and that will provide any flue clearance necessary for fire safety.
(2) Safe operation and servicing of the device so that any discharge meets the applicable requirements of Sec. 159.53.
(3) Cleaning, winter layup, and ash or sludge removal.
(4) Installation of a vent or flue pipe.
(5) The type and quantity of chemicals that are required to operate the device, including instructions on the proper handling, storage and use of these chemicals.
(6) Recommended methods of making required plumbing and electrical connections including fuel connections and supply circuit overcurrent protection.

(b) The instructions supplied by the manufacturer must include the following information:
(1) The name of the manufacturer.
(2) The name and model number of the device.
(3) Whether the device is certified for use on an inspected, or uninspected vessel.
(4) A complete parts list.
(5) A schematic diagram showing the relative location of each part.
(6) A wiring diagram.
(7) A description of the service that may be performed by the user without coming into contact with sewage or chemicals.
(8) Average and peak capacity of the device for the flow rate, volume, or number of persons that the device is capable of serving and the period of time the device is rated to operate at peak capacity.
(9) The power requirements, including voltage and current.
(10) The type and quantity of fuel required.
(11) The duration of the operating cycle for unitized incinerating devices.
(12) The maximum angles of pitch and roll at which the device operates in accordance with the applicable requirements of Sec. 159.53.
(13) Whether the device is designed to operate in salt, fresh, or brackish water.
(14) The maximum hydrostatic pressure at which a pressurized sewage retention tank meets the requirements of Sec. 159.111.
(15) The maximum operating level of liquid retention components.
(16) Whether the device is Type I, II, or III.
(17) A statement as follows:

Note: The EPA standards state that in freshwater lakes, freshwater reservoirs or other freshwater impoundments whose inlets or outlets are such as to prevent the ingress or egress by vessel traffic subject to this regulation, or in rivers not capable of navigation by interstate vessel traffic subject to this regulation, marine sanitation devices certified by the U.S. Coast Guard installed on all vessels shall be designed and operated to prevent the overboard discharge of sewage, treated or untreated, or of any waste derived from sewage. The EPA standards further state that this shall not be construed to prohibit the carriage of Coast Guard-certified flow-through treatment devices which have been secured so as to prevent such discharges. They also state that waters where a Coast Guard-certified marine sanitation device permitting discharge is allowed include coastal waters and estuaries, the Great Lakes and interconnected waterways, freshwater lakes and impoundments accessible through locks, and other flowing waters that are navigable interstate by vessels subject to this regulation (40 CFR 140.3).

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15325, Apr. 12, 1976]

Sec. 159.59 Placard.

Each device must have a placard suitable for posting on which is printed the operating instructions, safety precautions, and warnings pertinent to the device. The size of the letters printed on the placard must be one-eighth of an inch or larger.

Sec. 159.61 Vents.

Vents must be designed and constructed to minimize clogging by either the contents of the tank or climatic conditions such as snow or ice.

Sec. 159.63 Access to parts.

Each part of the device that is required by the manufacturer's instructions to be serviced routinely must be readily accessible in the installed position of the device recommended by the manufacturer.

Sec. 159.65 Chemical level indicator.

The device must be equipped with one of the following:
(a) A means of indicating the amount in the device of any chemical that is necessary for its effective operation.
(b) A means of indicating when chemicals must be added for the proper continued operation of the device.

Sec. 159.67 Electrical component ratings.

Electrical components must have current and voltage ratings equal to or greater than the maximum load they may carry.

Sec. 159.69 Motor ratings.

Motors must be rated to operate at 50 deg.C ambient temperature.

Sec. 159.71 Electrical controls and conductors.

Electrical controls and conductors must be installed in accordance with good marine practice. Wire must be copper and must be stranded. Electrical controls and conductors must be protected from exposure to chemicals and sewage.

Sec. 159.73 Conductors.

Current carrying conductors must be electrically insulated from non-current carrying metal parts.

Sec. 159.75 Overcurrent protection.

Overcurrent protection must be provided within the unit to protect subcomponents of the device if the manufacturer's recommended supply circuit overcurrent protection is not adequate for these subcomponents.

Sec. 159.79 Terminals.

Terminals must be solderless lugs with ring type or captive spade ends, must have provisions for being locked against movement from vibration, and must be marked for identification on the wiring diagram required in Sec. 159.57. Terminal blocks must be nonabsorbent and securely mounted. Terminal blocks must be provided with barrier insulation that prevents contact between adjacent terminals or metal surfaces.

Sec. 159.81 Baffles.

Baffles in sewage retention tanks, if any, must have openings to allow liquid and vapor to flow freely across the top and bottom of the tank.

Sec. 159.83 Level indicator.

Each sewage retention device must have a means of indicating when the device is more than \3/4\ full by volume.

Sec. 159.85 Sewage removal.

The device must be designed for efficient removal of nearly all of the liquid and solids in the sewage retention tank.

Sec. 159.87 Removal fittings.

If sewage removal fittings or adapters are provided with the device, they must be of either 1\1/2\" or 4" nominal pipe size.

Sec. 159.89 Power interruption: Type I and II devices.

A discharge device must be designed so that a momentary loss of power during operation of the device does not allow a discharge that does not meet the requirements in Sec. 159.53.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15326, Apr. 12, 1976]

Sec. 159.93 Independent supporting.

The device must have provisions for supporting that are independent from connecting pipes.

Sec. 159.95 Safety.

(a) Each device must--
(1) Be free of design defects such as rough or sharp edges that may cause bodily injuries or that would allow toxic substances to escape to the interior of the vessel;
(2) Be vented or provided with a means to prevent an explosion or over pressurization as a result of an accumulation of gases; and
(3) Meet all other safety requirements of the regulations applicable to the type of vessel for which it is certified.
(b) A chemical that is specified or provided by the manufacturer for use in the operation of a device and is defined as a hazardous material in 46 CFR Part 146 must be certified by the procedures in 46 CFR Part 147.
(c) Current carrying components must be protected from accidental contact by personnel operating or routinely servicing the device. All current carrying components must as a minimum be of drip-proof construction or be enclosed within a drip-proof compartment.

Sec. 159.97 Safety: inspected vessels.

The Commandant approves the design and construction of devices to be certified for installation and operation on board inspected vessels on the basis of tests and reports of inspection under the applicable marine engineering requirements in Subchapter F of Title 46, Code of Federal Regulations, and under the applicable electrical engineering requirements in Subchapter J of Title 46 Code of Federal Regulations.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15326, Apr. 12, 1976]

Sec. 159.101 Testing: general.

Unless otherwise authorized by the Coast Guard, a recognized facility must perform each test described in Secs. 159.103 through 159.131. The same device must be used for each test and tested in the order in which the tests are described. There must be no cracking, softening, deterioration, displacement, breakage, leakage or damage of components or materials that affects the operation or safety of the device after each test described in Secs. 159.103 through 159.117 and Sec. 159.121, and the device must remain operable after the test described in Sec. 159.119. The device must be set up in a manner simulating installation on a vessel in accordance with the manufacturer's instructions with respect to mounting, water supply, and discharge fittings.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15326, Apr. 12, 1976]

Sec. 159.103 Vibration test.

The device, with liquid retention components, if any, filled with water to one-half of their volume, must be subjected to a sinusoidal vibration for a period of 12 hours, 4 hours in each of the x, y, and z planes, at the resonant frequency of the device (or at 55 cycles per second if there is no resonant frequency between 10 to 60 hertz) and with a peak amplitude of 0.019 to 0.021 inches.

Sec. 159.105 Shock test.

The device, with liquid retention components, if any, filled with water to half of their volume, must be subjected to 1,000 vertical shocks that are ten times the force of gravity (10g) and have a duration of 20-25 milliseconds measured at the base of the half-sine shock envelope.

Sec. 159.107 Rolling test.

(a) The device, with liquid retention components, if any, filled with water to half of their volume, must be subjected to 100 cycles with the axis of rotation 4 feet from the centerline of the device, no more than 6 inches below the plane of the bottom of the device, and parallel to any tank baffles. The device must then be rotated 90 degrees on its vertical axis and subjected to another 100 cycles. This testing must be repeated with the liquid retention components filled to the maximum operating level as specified by the manufacturer in Sec. 159.57.

(b) Eighty percent of the rolling action must be approximately 15 degrees on either side of the vertical and at a cyclic rate of 3 to 4 seconds. Twenty percent motions must be approximately 30 degrees, or the maximum angle specified by the manufacturer under Sec. 159.57, whichever is greater, on either side of the vertical at a cyclic rate of 6 to 8 seconds.

Sec. 159.109 Pressure test.

Any sewage retention tank that is designed to operate under pressure must be pressurized hydrostatically at a pressure head of 7 feet or to 150 percent of the maximum pressure specified by the manufacturer for operation of the tank, whichever is greater. The tank must hold the water at this pressure for 1 hour with no evidence of leaking.

Sec. 159.111 Pressure and vacuum pulse test.

Liquid retention components of the device with manufacturer specified venting installed must be subjected to 50 fillings of water at a pressure head of 7 feet or the maximum pressure specified by the manufacturer for operation of the device, whichever is greater, and then emptied with a 45 gallon per minute or larger positive displacement pump that remains in operation 30 seconds after emptying the tank at the end of each cycle.

Sec. 159.115 Temperature range test.

(a) The device must be held at a temperature of 60 deg.C or higher for a period of 16 hours.

(b) The device must be held at a temperature of -40 deg.C or less for a period of 16 hours following winterization in accordance with manufacturers' instructions.

Sec. 159.117 Chemical resistance test.

(a) In each case where the recognized facility doubts the ability of a material to withstand exposure to the substances listed in paragraphs (b) and (c) of this section a sample of the material must be tested.

(b) A sample referred to in paragraph (a) of this section must be partially submerged in each of the following substances for 100 hours at an ambient temperature of 22 deg.C.

(1) Sewage.

(2) Any disinfectant that is required in the operation of the device.

(3) Any chemical compound in solid, liquid or gaseous form, used, emitted or produced in the operation of the device.

(4) Fresh or salt (3.5 percent Sodium Chloride) flush water.

(5) Toilet bowl cleaners.

(6) Engine Oil (SAE/30).

(7) Ethylene Glycol.

(8) Detergents (household and bilge cleaning type).

(c) A sample of the material must be doused 20 times, with a 1 hour drying period between dousings, in each of the following substances:

(1) Gasoline.

(2) Diesel fuel.

(3) Mineral spirits.

(4) Turpentine.

(5) Methyl alcohol.

Sec. 159.119 Operability test; temperature range.

The device must operate in an ambient temperature of 5 deg.C with inlet operating fluid temperature varying from 2 deg.C to 32 deg.C and in an ambient temperature of 50 deg.C with inlet operating fluid temperature varying from 2 deg.C to 32 deg.C.

Sec. 159.121 Sewage processing test.

(a) The device must process human sewage in the manner for which it is designed when tested in accordance with this section. There must be no sewage or sewage-treating chemicals remaining on surfaces or in crevices that could come in contact with a person using the device or servicing the device in accordance with the instructions supplied under Sec. 159.57(b)(7).

(b) During the test the device must be operated and maintained in accordance with the manufacturer's instructions. Any initial start-up time specified by the manufacturer must be allowed before test periods begin. For 1 hour of each 8-hour test period, the device must be tilted to the maximum angles specified by the manufacturer under Secs. 159.55 and 159.57.

(c) Except for devices described in paragraph (d) of this section, the devices must process and discharge or store human sewage over at least an 8-consecutive hour period on at least 10 days within a 20-day period. The device must receive human sewage consisting of fecal matter, urine, and toilet paper in a ratio of four urinations to one defecation with at least one defecation per person per day. Devices must be tested at their average rate of capacity as specified in Sec. 159.57. In addition, during three periods of each day the system must process sewage at the peak capacity for the period of time it is rated at peak capacity.

(d) A device that processes and discharges continuously between individual use periods or a large device, as determined by the Coast Guard, must process and discharge sewage over at least 10-consecutive days at the average daily capacity specified by the manufacturer. During three periods of each day the system must process sewage at the peak capacity for the period of time it is rated at peak capacity. The sewage for this test must be fresh, domestic sewage to which primary sludge has been added, as necessary, to create a test sewage with a minimum of 500 miligrams of suspended solids per liter.

Sec. 159.123 Coliform test: Type I devices.

(a) The arithmetic mean of the fecal coliform bacteria in 38 of 40 samples of effluent discharged from a Type I device during the test described in Sec. 159.121 must be less than 1000 per 100 milliliters when tested in accordance with 40 CFR Part 136.

(b) The 40 samples must be taken from the device as follows: During each of the 10-test days, one sample must be taken at the beginning, middle, and end of an 8-consecutive hour period with one additional sample taken immediately following the peak capacity processing period.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15326, Apr. 12, 1976]

Sec. 159.125 Visible floating solids: Type I devices.

During the sewage processing test (Sec. 159.121) 40 effluent samples of approximately 1 liter each shall be taken from a Type I device at the same time as samples taken in Sec. 159.123 and passed expeditiously through a U.S. Sieve No. 12 as specified in ASTM E 11 (incorporated by reference, see Sec. 159.4). The weight of the material retained on the screen after it has been dried to a constant weight in an oven at 103 deg.C. must be divided by the volume of the sample and expressed as milligrams per liter. This value must be 10 percent or less of the total suspended solids as determined in accordance with 40 CFR Part 136 or at least 38 of the 40 samples.

Note: 33 U.S.C. 1321(b)(3) prohibits discharge of harmful quantities of oil into or upon the navigable waters of the United States or adjoining shorelines or into or upon the waters of the contiguous zone. Under 40 CFR 110.3 and 110.4 such discharges of oil include discharges which:

(a) Violate applicable water quality standards, or

(b) Cause a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or cause a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines. If a sample contains a quantity of oil determined to be harmful, the Coast Guard will not certify the device.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15326, Apr. 12, 1976; USCG-1999-5151, 64 FR 67176, Dec. 1, 1999]

Sec. 159.126 Coliform test: Type II devices.

(a) The arithmetic mean of the fecal coliform bacteria in 38 of 40 samples of effluent from a Type II device during the test described in Sec. 159.121 must be 200 per 100 milliliters or less when tested in accordance with 40 CFR Part 136.

(b) The 40 samples must be taken from the device as follows: During each of the 10 test days, one sample must be taken at the beginning, middle and end of an 8-consecutive hour period with one additional sample taken immediately following the peak capacity processing period.

[CGD 75-213, 41 FR 15326, Apr. 12, 1976]

Sec. 159.126a Suspended solids test: Type II devices.

During the sewage processing test (Sec. 159.121) 40 effluent samples must be taken at the same time as samples are taken for Sec. 159.126 and they must be analyzed for total suspended solids in accordance with 40 CFR Part 136. The arithmetic mean of the total suspended solids in 38 of 40 of these samples must be less than or equal to 150 milligrams per liter.

[CGD 75-213, 41 FR 15326, Apr. 12, 1976]

Sec. 159.127 Safety coliform count: Recirculating devices.

Thirty-eight of forty samples of flush fluid from a re-circulating device must have less than 240 fecal coliform bacteria per 100 milliliters. These samples must be collected in accordance with Sec. 159.123(b) and tested in accordance with 40 CFR Part 136.

[CGD 73-83, 40 FR 4624, Jan. 30, 1975, as amended by CGD 75-213, 41 FR 15326, Apr. 12, 1976]

Sec. 159.129 Safety: Ignition prevention test.

(a) Components of a device that are a potential ignition source in an explosive atmosphere must pass the test in paragraph (b) or (c) of this section or meet the requirements of paragraph (d) or have a specific warning in the instruction manual required by Sec. 159.57 that the device should not be installed in an explosive atmosphere.

(b) Components protected by vapor exclusion must be placed in a chamber filled with a rich mixture of gasoline or propane in air with the pressure being varied from 0 to 2 psig once an hour for 8 hours. Vapor readings must be taken in the void being protected and must indicate a leakage less than 20 percent of the lower explosive limit of the mixture in the chamber.

(c) Components providing ignition protection by means other than vapor exclusion must be fitted with an ignition source, such as a spark plug, and a means of injecting an explosive mixture of gasoline or propane and air into the void that protects the component. Connections must be made so as to minimize any additional volume added to the protected void by the apparatus delivering the explosive mixture. The component must be placed in a chamber filled with an explosive mixture and there must be no ignition of the explosive mixture surrounding the component when the following tests are conducted:

(1) Using any overload protection that is part of the device, the potential ignition source must be operated for one half hour at 110 percent of its rated voltage, one half hour at 50 percent of its rated voltage and one half hour at 100 percent of its rated voltage with the motor or armature locked, if the potential ignition source is a motor or part of a motor's electrical circuit.

(2) With the explosive mixture in the protected void, the test installed ignition source must be activated 50 times.

(3) The tests paragraphs (c) (1) and (2) of this section must be repeated with any plugs removed.

(d) Components that are certified as being intrinsically safe in accordance with the Instrument Society of America (RP 12.2) or explosion proof in accordance with the Underwriters Laboratories STD 698 in Class I, Group D hazardous locations (46 CFR 111.80-5(a)) need not be subjected to this testing.

Sec. 159.131 Safety: Incinerating device.

An incinerating device must not incinerate unless the combustion chamber is closed, must purge the combustion chamber of combustible fuel vapors before and after incineration must secure automatically if the burner does not ignite, must not allow an accumulation of fuel, and must neither produce a temperature on surfaces adjacent to the incineration chamber higher than 67 deg.C nor produce a temperature on surfaces in normal body contact higher than 41 deg.C when operating in an ambient temperature of 25 deg.C. Unitized incineration devices must completely burn to a dry, inert ash, a simultaneous defecation and urination and must not discharge fly ash, malodors, or toxic substances.

Subpart D--Recognition of Facilities

Sec. 159.201 Recognition of facilities.

A recognized facility is an independent laboratory accepted by the Coast Guard under 46 CFR 159.010 to perform the tests and inspections required under this part. A list of accepted laboratories is available from the Commandant (G-MSE-3).

[CGD 95-028, 62 FR 51194, Sept. 30, 1997, as amended by USCG-1999-5832, 64 FR 34715, June 29, 1999]